RADIO and ELECTRONICS

ELECTRICITY — COMMUNICATIONS — SERVICE — SOUND

DECEMBER 1st, 1949 VOL. 4, NO. 10

1/10

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RADIO and ELECTRONICS

Vol. 4, No. 10 December 1st, 1949

OUR COVER

This month we feature a photograph of a radio-controlled sail-plane constructed and flown by Mr. L. H. Wright, who gives us a further article on radio control on page 33 of this issue.

For those interested in the aerodynamic side of things, the model has a span of 12 feet and an all-up weight of 6 lb., giving it a wing-loading capacity of approximately 9.6 oz. per square foot. In the corner of the picture is the portable control transmitter, which works on the 52.5 to 54 mc/sec. amateur band which is laid down for model control purposes.

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With Best Wishes for Xmas and the New Year

The Editor and staff of *Radio and Electronics* take this opportunity of wishing all our friends, whether readers or advertisers (or both) the best of Christmases and the happiest of New Years.

The year 1950, we hope, will be one of new ideas and added interest for all those engaged in radio, and we hope that it will be our good fortune to present readers with much up-to-date and original material. In fact, we feel that if *Radio and Electronics* can do this, it will have given to everyone a really worth-while Christmas present—twelve months of good radio reading. As to New Year resolutions—we have already made ours, and, while to divulge them here would be "telling,' we hope they will none of them be broken!

NEW ZEALAND RADIO MANUFACTURERS' FEDERATION

We enter again that period of increased recognition of goodwill and good tidings, the Festive Season, brightened this time for us by the lifting of the yoke of hampering price restrictions on competitive trading and enterprise. Now, too, we see dawning the first year of a new half-century—an era bearing the promise of scientific advancement and production innovations even excelling our industry's past triumphs.

The members of the New Zealand Radio Manufacturers' Federation, fully realizing their obligations and knowing their own strength, face the future with full confidence in their ability to develop every phase of radio and electronic advancement in New Zealand.

I can offer no better wish at this momentous time than that each and every member of our rapidly advancing industry may share the old happiness of Yuletide and the achievements of the approaching New Year and the New Era it brings.

WM. J. BLACKWELL, President.

THE NEW ZEALAND RADIO TRADERS' FEDERATION

The radio trader has, I think, found 1949 a year when general trading has proved to be a much more competitive business, and it is sincerely hoped that 1950 will show an improvement and turn out to be a highly satisfactory year.

Again I must emphasize the benefit of this Federation, which has so carefully watched the interests of members throughout the year, and not without success.

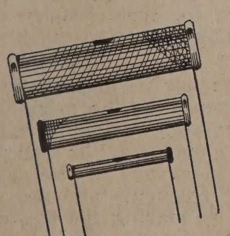
I take the opportunity of asking all radio traders to join up with the Federation without delay, as it is only through the aegis of a strong and full representative organization that the problems confronting the trade may be overcome.

I wish all members of the Federation and all associated with the radio trade a Happy Christmas and a Bright and Prosperous New Year.

G. J. MARKBY, President.

NEW ZEALAND ELECTRONICS INSTITUTE (INC.)

A message of goodwill from the President, Squadron Leader J. W. Todd, appears on page 44, where he stresses the need for consideration of two important factors—namely, service to members and the attainment of educational objectives by the Institute.



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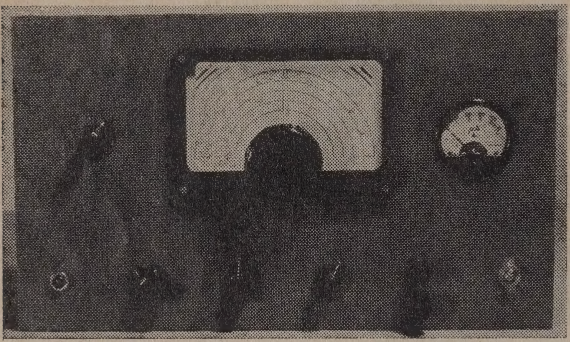
THE "RADEL" AUDIO SIGNAL GENERATOR

There have been published in these pages several designs for oscilloscopes, both 3 in. and 5 in. Many of our readers who have built them will feel the need for an oscillator which gives a sine-wave output at audio frequencies, and which can be used in conjunction with the 'scope for testing audio amplifiers, transmitters, etc. It is with this idea in mind that we present this article, which describes the design and construction of an oscillator which gives known voltage output at known frequencies within and beyond the audio range. Because of these useful features, the instrument to be described corresponds more to a standard signal generator than to "any old oscillator." In spite of this, it is easy to build, and uses only standard and commonly available parts.

INTRODUCTION

For some time we have been considering bringing out the design of an audio oscillator capable of being used in conjunction with an oscilloscope for the testing of audio amplifiers and the like. It may seem a



View of the completed oscillator.

comparatively simple thing to do, at first sight, but a little reflection on the problems involved soon dispels any false notions of this kind. What, then, are the requirements for an instrument of this sort, and what are the difficulties to be found in attempting to realize them?

(1) The frequency range should cover the whole useful range of audio frequencies.

(2) The waveform should be as close to a perfect sine-wave as possible, over the complete frequency range.

(3) The output should be constant at all frequencies, or should be capable of being held constant, so that frequency response curves can be plotted.

(4) There should be no great difficulties in construction, and, if possible, all parts should be standard radio components that are readily available.

(5) Any pre-set adjustments should be easily set, and should not require continual readjustment in order to keep the performance the same from time to time.

(6) The frequency stability should be good—that is, there should not be a need for frequent checking of the frequency to ensure that drifts, etc., have not occurred.

(7) Hum, noise, and other disturbances should be at a very low output level compared with that of the signal.

(8) The output voltage should be controllable without any effect on the frequency, waveform, or voltage calibration.

(9) The instrument should have a low output impedance—much lower than the input impedance of any amplifier or other device to which the signal must be fed.

(10) If possible, it should be arranged that calibrated output controls can be included, to enable gain measurements, etc., to be taken without the use of separate calibrated attenuators.

This is quite a formidable list, and to incorporate every desirable feature without finishing up with an over-complicated or costly design is really a considerable task.

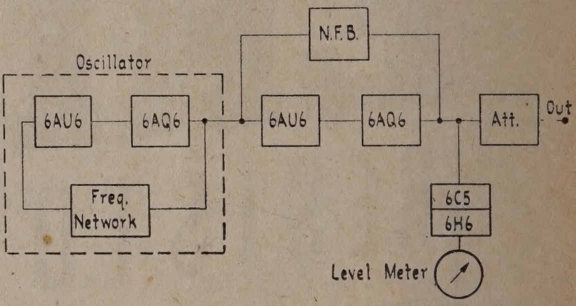
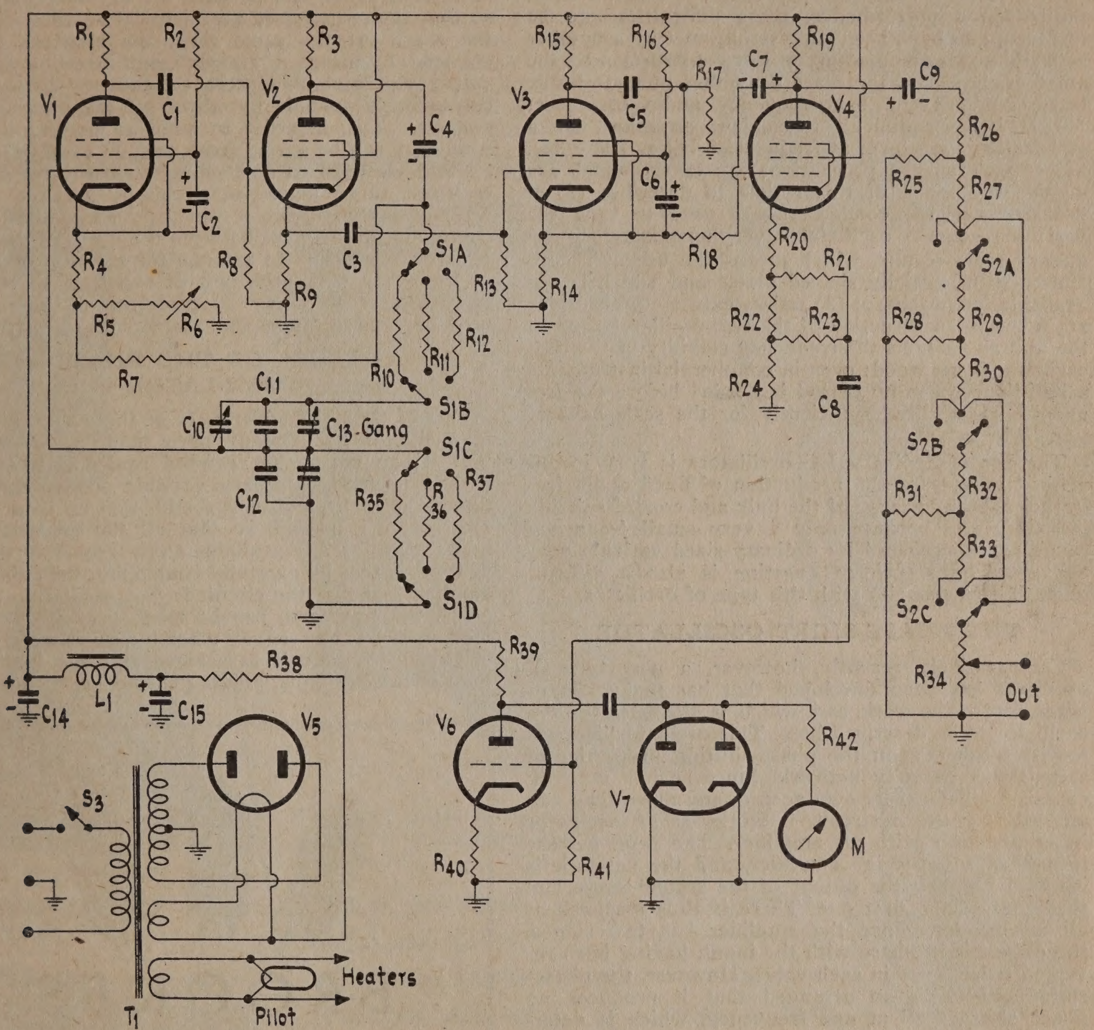


Fig. 1.—Block diagram.

AVAILABLE KINDS OF OSCILLATOR

A good many of the ten points above depend for their fulfilment on the type of oscillator circuit that is used, and since the beginning of radio as a branch of electrical engineering, a great deal of thought has been put into the question by instrument designers. Until comparatively recently, only two types of oscillator were used—beat-frequency oscillators and tuned-circuit oscillators, depending for their frequency on the resonance of inductance and capacity, much after the same fashion as various R.F. oscillator circuits. Of these two, the beat-frequency oscillator held the field for many years. It depends on the principle of beats, whereby two high-frequency oscillators are fed to a detector, which delivers output at the difference between their frequencies. Thus, one of the oscillators was operated on a fixed frequency and the other was made variable, so that by making the frequency of the latter variable from the frequency of the fixed oscillator to 20 kc/sec. higher (or lower), the difference frequency or beat frequency was changed from zero to 20 kc/sec. This scheme is superficially very attractive, and at first sight it might appear that a very simple audio oscillator could be constructed along these lines that would automatically give a number of the desirable features we have listed. Such is not the case, however, as in practice certain difficulties occur which make a simple and low-priced



COMPONENT LIST

V_1, V_3, 6AU6
V_2, V_4, 6AQ5
V_5, 5Y3-GT
V_6, 6C5
V_7, 6H6
R_1, R_{15}, 10k.
R_2, R_8, R_{13}, R_{16}, R_{17}, R_{37}, R_{42}, 100k.
R_3, R_{19}, 2k. 10 watt
R_4, 500 ohms
R_5, 700 ohms
R_6, 100 ohms Rheostat
R_7, R_{14}, R_{18}, 2k.
R_9, R_{23}, 250
R_{10}, R_{35}, 10 meg.
R_{11}, R_{36}, 1 meg.
R_{12}, R_{41}, 500k.
R_{20}, R_{21}, R_{24}, 100 ohms
R_{22}, 50 ohms
R_{25}, R_{26}, R_{27}, see text
R_{28}, R_{31}, 202 ohms, see text
R_{29}, R_{30}, R_{32}, R_{33}, 820 ohms, see text
R_{34}, 1000-ohm w-w pot.
R_{38}, 100 ohms 5 watts
R_{39}, 20k.
R_{40}, 1k.
C_1, C_3, C_5, C_8, 0.25 μf. 400v. paper
C_2, C_4, C_6, C_7, C_{15}, 16 μf. 450v. electro.
C_9, C_{14}, 40 μf. 450v. electro.
C_{10}, 3-30 $\mu\mu$f. Philips trimmer
C_{11}, C_{12}, 15 $\mu\mu$f. silvered ceramic
C_{13}, 420 $\mu\mu$f. max. cap. two-gang
S_{1a} to S_{1d}, 4-pole 3-pos. wafer
S_{2a} to S_{2c}, 3-pole 3-pos. wafer
S_3, A.C. on/off switch
T_1, 310 v.-a-side, 100 ma.
L_1, 100 ma. smoothing choke
M, 0-500 μamp. moving coil

beat-frequency oscillator almost an impossibility. Where price is very little object to the attainment of the required performance, these difficulties can be resolved, and have been successfully met by a number of well-known manufacturers. For construction by the amateur, however, there are a number of undesirable features about the beat-frequency audio oscillator: (1) It is very difficult to achieve anything like a satisfactory waveform at frequencies below 100 c/sec. unless very special precautions are taken, which are outside the scope of this article to describe; (2) if ordinary variable condensers are used to tune the variable-frequency oscillator, a very unsatisfactory frequency scale results, which means the use of a condenser with specially shaped plates and which is not available for purchase; (3) unless extreme precautions are taken in construction of the two oscillators and of the unit as a whole, the frequency stability of the beat oscillator is not good; even in commercial instruments a half-hour warm-up period is needed before the frequency is stabilized sufficiently for the scale calibration to be useful.

The use of ordinary LC oscillators is very inconvenient except for the production of fixed audio frequencies, both because of the bulk and cost of suitable inductors and because only a very small frequency range can be covered by ordinary-sized variable condensers. The waveform question is also a difficult one at all frequencies with this type of oscillator.

THE PHASE-SHIFT OSCILLATOR

Comparatively recently, however, a new type of oscillator has been developed that has many advantages for audio work and which is the basis of the oscillator to be described here. This oscillator depends for its frequency on the phase-shifting properties of a resistance-capacity network. Since such a network cannot oscillate of its own accord, any more than can an ordinary tuned circuit, it works as an oscillator in conjunction with an amplifier. The type we are using has a two-stage amplifier, and the network is inserted between the output of the second stage and the input of the first one. There is thus feedback at all frequencies. Since the amplifier has two stages, the output is in phase with the input, having been reversed twice, once in each valve. However, the phase-shift network is so arranged that it produces no phase shift at all at one frequency, which is determined by the values of resistance and capacity. At that frequency only, therefore, is the output of the network truly in phase with the voltage at the input, with the result that the circuit oscillates at this frequency to the exclusion of all others. At all other frequencies, the network produces a phase shift that is greater the farther the frequency is from the one of zero phase shift. For this reason, the feedback at other frequencies, while still positive in direction, is not so strong, and the circuit refuses to oscillate at any frequency other than the one at which the RC network has zero phase shift. Now, this network contains only two resistors and two condensers, and for proper operation the resistors and condensers should at all times be equal. It can be seen, therefore, that the network is very well suited to the production of an oscillator whose frequency can be varied either continuously, or in steps, or both.

For example, the condensers can be made sections of a gang, as used in ordinary radio receivers. This gives us a means of continuous frequency variation, since gang condenser sections are accurately matched so that their capacities are identical at all settings of the shaft. At the same time, the resistors can be changed, by means of a switch, and inserting different values will give us different frequency bands, each continuously tunable by means of the variable condensers. Thus, in order to build an oscillator whose frequency can be varied from, say, 30 to 30,000 c/sec., all that we need to do is to arrange several pairs of resistors, to be placed in circuit by a range switch, whereupon the variable condenser gang allows us a continuous adjustment between the limits of any band. It is quite possible to arrange for a sweep of 10 to 1 in frequency with each pair of resistors, so that, for an oscillator to cover 30 c/sec. to 30 kc/sec., we need only three ranges and three pairs of resistors.

ADVANTAGES OF THE PHASE-SHIFT OSCILLATOR

One of the chief advantages of the phase-shift type of oscillator has already been made clear—namely, that it can cover the required range of frequencies with a perfectly ordinary variable condenser as the tunable element, and, better still, that no inductors of any sort are needed, so that all the essential components are readily available anywhere. A further advantage is that by carefully controlling the gain of the amplifier, so that the circuit is just oscillating and no more, the waveform can be made very good indeed. Nor is there any effect whereby good wave shape is any more difficult to achieve at some frequencies than at others. Thus, points (1) and (2) of our list of

requirements have been met already. As to (3), constancy of output over the frequency range, this can quite easily be looked after, too. Some commercial oscillators working on this principle employ an automatic gain control system which ensures automatically that the amplitude of the oscillation is constant and at a level just above that at which oscillation can be sustained. The system of gain control is not at all similar to the ordinary A.V.C. system such as radio sets use, but depends on variation of negative feedback by means of a low-wattage lamp, which is used as part of the feedback network. As the current through the lamp changes, so does its resistance, and hence the amount of negative feedback alters at the same time, in such a direction as to oppose any change in output level. This system, though accurate, depends on the characteristics of a particular type of lamp, which is not generally available, and so we have been compelled to forgo its use, in spite of its advantages. Instead, we have included a feedback control, which appears on the front panel of the instrument, and enables the output level to be set with the aid of a meter.

Point (4) is amply attained. The construction contains no difficulties at all and no components that cannot be bought anywhere.

Points (5), (6), and (7) are also fully satisfied. In particular, the frequency stability is excellent, and because three ranges are used to cover the audio spectrum, frequency setting on the higher part of the range is easier than with other types of oscillator, including beat-frequency oscillators. The remaining points, (8) to (10), are not, properly speaking, functions of the actual oscillator circuit at all, and are all tied up with the design of suitable auxiliary circuits, which are included in the instrument in order to add to its usefulness.

GENERAL SCHEME OF THE INSTRUMENT

The general make-up of the signal generator can be seen from the block diagram, Fig. 1. The first two valves, a 6AU6 and a 6AQ5, comprise the oscillator amplifier, and, in conjunction with the phase-shift network, make up the oscillator proper. The next two valves, which are also a 6AU6 and a 6AQ5, constitute a power amplifier. This has the dual purpose of isolating the output circuit from the oscillator circuit and of providing power amplification, so that a comparatively large output voltage can be obtained across a low output impedance. The output voltage decided upon was 10 volts R.M.S., and the output attenuator has an impedance of 1000 ohms, so that the power needed is 0.1 watts. This is not very great, and it might be thought that it could very easily be obtained with a very much smaller output valve and a lower current drain from the power supply. This would be the case if it were permissible to use an output transformer in order to realize the low output impedance.

It was decided, however, that builders would not wish to have the expense of buying a special output transformer of the best possible characteristics, and that resistance coupling throughout would be preferable. Also, there are good technical reasons why an output transformer is undesirable. Unless it were of the highest quality, it would not be possible to keep the output of the signal generator constant over the whole audio frequency range; in addition, it is useful to have an audio generator which delivers output at frequencies considerably higher than normal audio frequencies, if this can be done without much trouble. By using resistance coupling in the output of the power amplifier, it is possible to keep the output level constant up to the top oscillator frequency of 40 kc/sec., so that, if necessary, amplifiers may be tested well outside the audio range. The price paid for this wide response is low efficiency in the amplifier, but, since this only means providing a few more milliamps drain from the H.T. supply, the price is not a difficult one to pay.

To a large extent, the same considerations apply to the oscillator amplifier, so that here, too, it is desirable to use a power valve in the second stage. Here, the output impedance is kept low as an aid to keeping the amplifier's frequency response level up to much higher frequencies than the top oscillation frequency that is wanted.

The remaining two valves, a 6H6 and a 6C5, are used as a rectifier and isolating amplifier respectively for the level-indicator meter. The latter is needed so that the input voltage to the output attenuator can always be set to the same value when frequency response figures are wanted. Also, it is by keeping the oscillation amplitude very low that the excellent waveform of the oscillator is assured. Thus, it can be seen that the level indicator circuit is not just a "frill" but a necessary part of the circuit. As mentioned above, it replaces the somewhat critical automatic amplitude control that is found in many commercial instruments.

The output attenuator consists of three T-section attenuators, with attenuations of 1 db., 10 db., and 20 db. respectively. The first of these has the purpose of isolating the rest of the attenuation circuit from the amplifier output terminal and at the same time of reducing the amplifier output to just 10 volts at

(Continued on page 48.)

THE 80-40-20 BANDSPREAD TUNER

PART 2

Note.—For full circuit and photographs, please see "Radio and Electronics" for October, 1949.

OTHER POINTS ABOUT THE CIRCUIT

Since the best possible performance was wanted, as well as complete bandspread, it was decided to use Faraday shields between the aerial coil primary windings and the secondaries. These shields can be seen in the photograph of the unit, and are made from 20-gauge (or thinner) tinned copper wire. In order that the aerial arrangements should suit any aerial, the aerial coils are all centre-tapped, and three aerial terminals are provided. Thus, if the aerial coupling is to be from a balanced two-wire line, as is most likely when the transmitting aerial is to be used for receiving also, the two outer terminals are used for connecting the line. The use of a Faraday shield ensures that the balance of the line is preserved, and that radiation picked up by the line itself is not coupled into the receiver. The centre aerial terminal, which connects to the centre-taps of the aerial coils, should be grounded to the chassis in this case, as this will provide an earth return for any noise voltages picked up by the line, and, in conjunction with the Faraday shield, will ensure that noise is not coupled into the set from the line. It is popularly supposed that using a balanced line from a half-wave aerial will automatically cancel out noise picked up by the transmission line, but, unless there is no capacity coupling between the aerial winding and the grid winding, this does not become effective. The three-terminal aerial coil enables proper noise cancellation to take place.

If, on the other hand, an ordinary single-wire aerial is to be used, the ends of the aerial coil nearest to the Faraday shield can be earthed by earthing the appropriate aerial terminal of the three. Then, the other two terminals can be used to give two different degrees of aerial coupling. With a long aerial, results may be found better with only half the aerial coil in use, while, for a short aerial, the whole coil can be made use of.

Even here, the Faraday shield is useful, because it eliminates capacity coupling between the aerial and the grid coil, with the result that less de-tuning of the grid circuit takes place than usual, and tracking on the 80-metre band is not destroyed when the aerial is connected.

It will be noted that the coupling between the oscillator and mixer sections of V_8 is made with two very small condensers, C_{24} and C_{28}, connected between the oscillator grid and the mixer grid. These condensers are made from pieces of twisted hook-up wire, and are very minute, being approximately 1.5 and 3.0 $\mu\mu$f. respectively. They can be seen wired to the wave-change switch in one of the underneath photographs. It is of no use to try to increase the sensitivity by increasing the size of these condensers. If this is done, oscillator pulling takes place, and it is very difficult to get the V_8 grid circuit and the V_8 oscillator circuit properly tuned. With the condensers shown, however, no difficulty is experienced.

On 80 metres, of course, the complete bandspread is obtained by the usual method of using series and parallel trimmers with each section of the gang condenser. Reference to the component list shows that all the series and parallel trimmers are 3-30 $\mu\mu$f. Philips trimmers. Because the set was being specially designed for 80 metres, it was possible to use much better L/C ratios in the tuned circuits than can ever be done when a general-coverage set is being designed. This, in part, accounts for the extremely high sensitivity and signal-to-noise ratio of the tuner. The 80-metre coils were designed for a minimum capacity of only 30 $\mu\mu$f., with the result that, for the frequency, the coils have a much larger inductance than usual, and therefore higher gain. Reference to the coil construction data will show that the 20-metre coils, in particular, are relatively enormous for this frequency.

Because series condensers are used with all sections of the condenser gang, there is no need for a padder in the 80-metre oscillator coil. It will be seen that the oscillator coil has less inductance than the signal circuit coils, after the usual manner of tracked oscillator coils, and, also, if the photograph is inspected closely it will be seen that the series trimmer in the centre gang section (the oscillator one) is further out than the other two. This condenser is thus acting as the padder by reducing the capacity of the oscillator section of the gang in the same way as an ordinary padder does.

The wiring of the ECH21 is slightly different from that of other similar tubes in that the oscillator grid and the injection grid of the heptode section are not internally connected, but are brought out to separate pins on the valve base. The connection thus has to be made externally. Also, in order to get enough base pins to accommodate the extra electrode, the locating spigot in the centre has been made the cathode connection as well. The whole of the metal ring round the base of the valve is thus connected to the cathode, so that it must be insulated from the chassis when cathode bias is used, to prevent short-circuiting of the bias resistor. This simply means that the loctal socket should be mounted above the chassis, so that when the valve is plugged in its base cannot touch the chassis.

The output of the unit has simply been shown as the secondary of the 455 kc/sec. I.F. transformer in the plate circuit of the ECH21. This transformer, however, has been placed on the unit's chassis so as to give a short lead for the ECH21's plate.

COIL SPECIFICATIONS

All coils are wound on ¾ in. diameter formers, and are close wound. As can be seen in the photographs, the 80-metre coils all have four or five turns at the "hot" end spaced from the main winding by approximately ¼ in. This is to allow of slight adjustments to the inductance by slipping some of these turns back on to the main winding, or vice versa. It should be noted that the number of turns quoted for the 80-metre windings INCLUDE these spaced turns.

The 80-metre coils are all wound with 30-gauge enamelled wire, as are the 40-metre coils. The 20-metre ones are wound with 20-gauge enamelled wire. The following table gives details of all the R.F. transformers and coils.

Band		Tuned Windings T_1	T_2	T_3	T_4	T_5	L_1	L_2	L_3	L_4	T_6	Primaries T_1	T_2	T_3	T_4	T_5	T_6
80m.	Turns	—	—	50	—	—	50	—	—	50	46	—	—	16	—	—	14
	Gauge	—	—	30g.	—	—	30g.	—	—	30g.	30g.	—	—	30g.	—	—	30g
40m.	Turns	—	23	—	30	—	—	23	—	—	—	—	14	—	18	—	—
	Gauge	—	30g.	—	30g.	—	—	30g.	—	—	—	—	30g.	—	30g.	—	—
20m.	Turns	16	—	—	—	11	—	—	16	—	—	10	—	—	—	7	—
	Gauge	20g.	—	—	—	20g.	—	—	20g.	—	—	20g.	—	—	—	20g.	—

Note: All aerial coil primaries are centre-tapped.

The photographs show how the coils are mounted. The aerial coils are mounted with the "hot" ends towards the chassis, and the primaries are wound at the "cold" ends. The Faraday shields are inserted by using separate formers for the tuned windings and the aerial windings, and, after the former are mounted on the chassis, the Faraday shields are glued on to the ends of the formers. The small pieces of former, carrying the aerial windings are then glued on top of the Faraday shields.

CONSTRUCTION

There should not be very much need to say a great deal about this, because the chassis diagram and the photographs give a good idea of the lay-out of the unit. The wave-change switch is placed centrally on the chassis, which consists simply of a sheet of 16-gauge or heavier aluminium sheet, with a 3 in. deep flange bent over at one end. This makes the unit able to be plugged into a cut-out in a main chassis and held down with bolts at the edges. Since all coils are underneath, the unit presents a particularly clean appearance on top.

Underneath, a copper shield partition has been placed across the socket of the 6BA6 R.F. stage, and acts both as a shield between the plate and grid pins of this valve and as a support for the wave-change switch.

The aerial coils are all behind the shield partition, mounted on the chassis. The three R.F. plate coils, L_1, L_2, L_3, are the ones mounted actually on the front side of the partition, horizontally. The bracket on which the front plate of the wave-change switch is mounted is 2 in. from the front of the chassis. In front of this bracket, on either side of it, are the fixed oscillator coils, while the coil next to the 20m. oscillator is L_4, the 80m. coil in the plate circuit of the extra mixer, V_8.

BUILDING AND SETTING UP

In building this unit, the best plan is to do all the wiring between wafers of the wave-change switch, and also put in all condensers and resistors associated with the valves. Then, with the wave-change switch in the 80m. position, the 80m. coils are wound and installed. Getting things going on 80m. is no more difficult than lining up any other set, and if the coils are carefully made, so that the tuned windings of the aerial and R.F. coils are identical, all adjustments will be very straightforward. The first step is to adjust the 80m. oscillator coil. This can be done with the aid of a signal generator or frequency meter. Since the I.F. is 455 kc/sec., the frequency range of the oscillator must be 3955 to 4455 kc/sec. First of all, the series trimmer should be set at approximately half-scale, and the gang set fully open. Then, the parallel trimmer, C_{15}, is adjusted so that the oscillator frequency is 4455 kc/sec. This setting should come at approximately half out on the trimmer. Next, the gang is closed, and the series trimmer, C_{16}, is adjusted until the frequency is 3955 kc/sec. Now, on going back to the high-frequency end, it will probably be found that this is no longer correct, owing to the series trimmer having been shifted slightly. C_{15} is therefore adjusted again to bring the right frequency back, and a further check is made at the low-frequency end of the band. Going back and forth a few times, adjusting the parallel trimmer at the high-frequency end and the series one at the low-frequency end will get the band just right. If a frequency meter is not used to check the oscillator frequency directly, the 455 I.F. transformer can first be aligned, and exactly the same process gone through, with signals at 4000 and 3500 kc/sec. fed into the ECH21 grid.

After the oscillator has been adjusted in this way, it is set, once for all, and will not require further adjustment, so the next job is to install the R.F. plate coil, L_1. When this has been wired into place, a signal is fed into the 6BA6 grid at 4000 kc/sec. and is tuned in by means of the gang. The trimmer C_9 is then tuned for maximum response. Now, a 3500 kc/sec. signal is fed in and is also tuned in with the gang. The series trimmer C_{12} is now adjusted for maximum response. In the same way as with the oscillator coil, the band ends are adjusted alternately until both are correct. The R.F. plate coil can now be left alone. Finally, the aerial coil is installed and adjusted with the series and parallel trimmers, C_6 and C_7 respectively until alignment is correct at both ends of the band. The 80-metre band is now completely aligned, and will require no further attention.

ADJUSTING THE 40 AND 20-METRE BANDS

When the 80-metre band is a going concern, attention can be turned to the alignment of the 40 and 20-metre bands. The first thing to be done is to set the trimmer of L_4, the 80-metre tuned circuit in the plate of the extra mixer. This must be done first, because it is in use on both 20 and 40 metres. In order to adjust the trimmer, the wave-change switch is placed in the 40-metre position and a signal on 4000 kc/sec. is fed from the signal generator to the signal grid of the 6J6. The signal is now tuned in with the main dial and the trimmer across L_4 is adjusted for maximum output. This is all the adjustment needed, for, if the coil has been made identical with the other 80-metre circuits, only the minimum capacity has to be adjusted, since the series trimmers of the gang condensers have already been set to the correct position to give complete bandspread.

This done, the next job is to install the 40-metre oscillator coil and to set it to the correct frequency. To do this, the signal generator is still fed into the signal grid of the 6J6, but the frequency is now set at 7150 kc/sec., the centre of the band. Next, the main dial is set to the position where 3750 kc/sec. comes in on the 80-metre band—that is, to the centre of the 80-metre band itself. With both the signal generator and the main dial set in this way, it will not be possible to receive the signal generator's signal

until the oscillator section of the 6J6 is adjusted to the correct frequency of 3400 kc/sec. Therefore, without touching either the receiver tuning dial or the signal generator, the trimmer of the 40-metre oscillator coil is adjusted until the signal is heard in the output of the set. When it is, the oscillator trimmer is set exactly to the point for correct tuning of the signal, and left.

Now, all that remains to be done is to install the R.F. stage's 40-metre grid and plate coils, and tune them to resonance. It will have been noticed that the 40-metre R.F. plate coil has a resistor shunted across it. The purpose of this is to reduce the selectivity of the R.F. stage. If it is omitted, the stage is too selective, with the result that at the edges of the band the sensitivity is too far down compared with the middle of the band, where the tuning is exactly peaked up. First of all, the R.F. 40-metre plate coil is wired in, and the signal generator, still set to the mid-band frequency of 7150 kc/sec., is fed into the R.F. stage's grid. The main dial is then used to tune in the signal, and the 40-metre R.F. plate coil trimmer is adjusted for maximum response. The grid coil is now installed, and with the signal generator transferred to the aerial terminal, the grid trimmer is tuned for maximum response at 7150 kc/sec. The 40-metre band is now completely aligned, and it will be realized that the most difficult part of the lining-up procedure is not the adjustment of the 40 or 20-metre bands, but the initial adjustment of the 80-metre band for complete bandspread.

The 20-metre band is now proceeded with in exactly the same way as we have detailed for the 40-metre band. The only differences are that the fixed oscillator for the 20-metre band is to be adjusted to 10.45 mc/sec. and the R.F. grid and plate coils are peaked up on the centre frequency of the 20-metre band—namely, 14.2 mc/sec.

SOME FINER POINTS

If the small coupling condensers which inject the oscillator voltage from the oscillator section of the 6J6 to the mixer section are too large in capacity, one very undesirable effect becomes noticeable. It is that harmonics of the variable 80-metre oscillator are received by the tuner, just as though they were fixed frequency signals coming in through the aerial. Should these be present after the R.F. stage has been aligned, the reason is that the coupling condensers are too large, and they should be whittled down until the spurious signals are no longer heard. This trouble is likely to be encountered with any double conversion superheterodyne, and is one of the only points upon the double conversion set that can really be criticized. However, if due precautions are taken, as suggested, they should be so weak as to be inaudible, when they can not cause trouble by beating with true signals.

Once the principle of operation has been digested, it is clear why the same arrangement cannot be extended to include the 10-metre band. The scheme works for 40 and 20 metres only because these bands

(Concluded on page 48.)

The *Radio and Electronics* Abstract Service

AUDIO EQUIPMENT AND DESIGN:

Special Loudspeaker Systems. Part 3. Discussion of resonance, damping, feedback, and dividing networks. Details of design of corner cabinet to contain dual channel speaker system.
—Radio News (U.S.A.) (Radio & El. Ed.), Aug., 1949, p. 11.

ANTENNAE AND TRANSMISSION LINES:

Masthead Antennae Switching. Description of a commercially manufactured (U.S.) unit which will select any one of twelve antenna systems by use of push-button control. Developed for TV antennae; might well be adapted for amateur work.
—Radio News (U.S.A.), September, 1949, p. 42.

High-frequency Transmission Line Chart. Chart, developed from circle diagram and Smith chart, simplifies determination of input impedances and matching stub dimensions. Sample problems solved.—Electronics (U.S.A.), August, 1949, p. 104.

Adjusting Antenna Coupler and Harmonic Filter. Method described for adjusting a link-coupled antenna tuner with a harmonic filter in the coaxial link.
—QST (U.S.A.), August, 1949, p. 32.

CIRCUITS AND CIRCUIT ELEMENTS:

A Widerange Pulse Shaper. Circuit of unit which generates a single one-microsecond pulse manually, or may be triggered with sine waves to produce pulses at repetition rates up to 400 kc. Dual-triode valve used in "Schmitt" trigger circuit.
—Radio News (U.S.A.) (Radio & El. Ed.), Sept., 1949, p. 15.

Voltage Stabilizers. Part 4. Alternative bridge stabilizing. Circuits drawn. Appendix has mathematical analysis of circuits given in earlier parts. List of references.
—Electronic Engineering (Eng.), August, 1949, p. 300.

L-Section Low-pass Filter Design. Theory and design of low-pass filters based on L-sections, with chart developed for design work.—Communications (U.S.A.), July, 1949, p. 22.

Circuit Techniques for Miniaturization. Elimination of bulky cathode-bypass and screen bypass condensers by use of controlled positive feedback. By similar means, video amplifier compensating inductors can be replaced by small feedback condensers. Circuits drawn for high-frequency compensation through positive feedback.—Electronics (U.S.A.), August, 1949, p. 98.

Logarithmic-scale Noise Meter. Interesting circuit of a logarithmic D.C. voltmeter developed as an output meter for noise-measuring device. Other applications possible are electrical multiplication and division by addition and subtraction of logarithms.—Electronics (U.S.A.), August, 1949, p. 100.

Selectivity Calculations. For rapid solution of bandwidth and selectivity problems are provided: (1) Nomograph showing directly the effect of cascading up to ten single or double-tuned circuits; and (2) chart showing bandwidth at any attenuation up to 100 db. in terms of that for 3 db. attenuation for cascading up to ten single-tuned circuits.
—Electronics (U.S.A.), August, 1949, p. 112.

A Wideband Amplifier. 100 c/s. to 20 mc/s. Circuit of a two-stage filter coupled amplifier with cathode follower output.
—Electronic Engineering (Eng.), September, 1949, p. 338.

The Coffee-can V.F.O. Simple V.F.O. Circuit and construction. "Clapp" circuit, with 6V6 oscillator and 6V6 valve buffer stage.
—QST (U.S.A.), August, 1949, p. 22.

MICROWAVE TECHNIQUES:

"Midar" (Microwave Detection and Ranging). Circuit and design of an instrument which may be used for shortwave detection and alarm purposes. System is C.W. rather than pulsed transmission, and is capable of responding up to any minimum distance. Unit described uses only two 6V6 valves and operates as a feedback oscillator, the feedback acting through space coupling between two antennae and surrounding objects. The presence of extraneous bodies changes oscillation strength by changing total phasing of received waves. Indicator may be a plate milliammeter or C.R.T.
—Radio News (U.S.A.), August, 1949, p. 30.

The Electromagnetic Horn. Part 2. Outline of results obtained from tests on experimental horns of sectoral type, undertaken to investigate influence of flare angle and excitation wavelength on radiation characteristics. Design data provided.
—Electronic Engineering (Eng.), August, 1949, p. 299.

MEASUREMENTS AND TEST GEAR:

Measurement of Quality in Audio Reproduction. Part 2. Continued discussion of specific types of distortion. Measurement of transient and phase response and wow or flutter introduced by mechanical recording systems.
—Radio News (U.S.A.) (Rad. & El. Ed.), Aug., 1949, p. 9.

Part 3 (concluding) discusses measurements conducted on audio systems with a view to determining quality of reproduction.
—Radio News (U.S.A.) (Rad. & El. Ed.), Sept., 1949, p. 8.

A Pocket Signal Tracer. Details of compact signal tracer for A.M. broadcast receivers. Built into torchlight case. Uses 1N34 crystal diode and minimum number of parts.
—Radio News (U.S.A.), September, 1949, p. 50.

Sweep Generator Adjustment of Transmission Lines and Antennae. Describes method of using sweep generator to check transmission lines for flaws, measure standing wave ratios, adjust antennae and matching stubs for proper impedance match, and to ascertain whether T.V. receiver is properly matched to transmission line.
—**Radio News (U.S.A.), September, 1949, p. 52.**

Projective Three-dimensional Displays. Part 2. Stereoscopic displays, continued. Circuit of stereoscopic switching unit and general-purpose drive unit. Applications of apparatus described.
—**Electronic Engineering (Eng.), August, 1949, p. 281.**

Noise-generator Technique for V.H.F. Man. Improving receiver performance on 50 and 144 mc. by use of a noise generator, circuit of which is drawn. Unit uses a noise diode type of valve not obtainable in New Zealand, but general description of method of employing generator is of interest.
—**QST (U.S.A.), August, 1949, p. 20.**

RECEPTION AND RECEIVERS:

Widerange Bandpass Crystal Tuner. Circuit and constructional details of a tuner to cover 540-1750 kc. Uses bandpass network with high-Q coils and 1N34 crystal diode for detector. Unit is designed to operate in proximity to local station and to be followed by a high-gain amplifier.
—**Radio News (U.S.A.), August, 1949, p. 31.**

The Beginning Amateur. Article contains brief review of principal features of modern U.S. communications receivers in various price classes.—**Radio News (U.S.A.), August, 1949, p. 45.**

TELEVISION:

High-Gain Directional Array for Marginal T.V. Reception. Constructional details.
—**Radio News (U.S.A.), August, 1949, p. 28.**

Modern Television Receivers. Part 17. Sync pulse separation and its achievement in modern receivers.
—**Radio News (U.S.A.), August, 1949, p. 41.**

Part 18. Introduction to vertical sweep section. Servicing procedure outlined.—**Radio News (U.S.A.), September, 1949, p. 61.**

The Television Receiving Antenna. Part 1. Details of practical design and basic analysis of V.H.F. wave propagation.
—**Radio News (U.S.A.), August, 1949, p. 53.**

Part 2. Various types of antenna construction described, also transmission lines. Types are illustrated.
—**Radio News (U.S.A.), September, 1949, p. 67.**

Television Servicing with a Sweep Generator. Article discusses desirable characteristics in design of a sweep generator, and its use in T.V. servicing.
—**Radio News (U.S.A.), September, 1949, p. 46.**

TRANSMISSION AND TRANSMITTERS:

Self-modulating the 829-B. This valve is a U.S. twin tetrode. Experimental unit described consists of 6L6 oscillator-doubler (7 mc. crystal) driving 829-B valve on 14 mc. Doubling also in final stage gives 28 mc. output. 6SN7 valve used as cascade speech amplifier is transformer-coupled to one 829-B grid. Common cathode and screen of 829-B are modulated; 300 volts applied to anodes of 829-B valves.
—**Radio News (U.S.A.), September, 1949, p. 49.**

Your First Transmitter. Circuit and design of a simple 50-watt transmitter designed for operation on 80, 40, and 20-meter amateur bands. Consists of a crystal oscillator (Pierce) with 6C4 triode capacity-coupled to 807 output valve.
—**Radio News (U.S.A.), August, 1949, p. 26.**

Crystal-controlled Portable V.H.F. Transmitter. Circuit and construction of a three-valve transmitter designed for 150 mc. Battery operated and compact. Uses 8 mc. crystal operated on third overtone. Oscillator valve is 3A5 (dual-triode). Second triode section of valve acts as doubler, followed by 3B4 as tripler driving 3B4 amplifier. Interstage coupling is improved by double tuning. Total power input is 8 watts, and 1.5 watts are developed into load at 150 mc.
—**Radio News (U.S.A.), August, 1949, p. 34.**

Low Power Rig for C.W., F.M., or Phone. Circuit and construction of transmitter for V.F.O. controlled C.W. operation on 80 and 40-meter bands, V.F.O. controlled N.B.F.M. phone on 20 and 10-meter bands. Power input to final amplifier is 45 watts. Oscillator keying provides for break-in operation. Final amplifier is 807 valve.
—**Radio News (U.S.A.), August, 1949, p. 48.**

Frequency Doublers with Low-Q Tank Circuits. In practical cases it is sometimes desirable to adjust the carrier frequency of a transmitter over a moderate range without retuning of the buffer. An analysis indicates that Q of tank circuit of frequency doubler may be 25 or less in A.M. or F.M. systems without serious loss of efficiency.
—**Communications (U.S.A.), July, 1949, p. 13.**

A Bandswitching V.F.O. Exciter Unit. Circuit and construction of a V.F.O. exciter with output on 80, 40, 20, and 10-meter amateur bands. Incorporates N.B.F.M. reactance modulator. Has 807 valve in output.
—**Radio News (U.S.A.), September, 1949, p. 37.**

A 28 mc. Installation for the Car. Circuit and construction of simple 10-metre mobile station using valves with instant heating filaments. 2E20 valve operates as regenerative harmonic oscillator, quadrupling, with 40-metre crystal, to 10 metres and driving directly a 2E24 final amplifier valve. Modulator consists of pair of 2E20 valves in class AB2, driven from carbon microphone and p-p input transformer. Miniature parts used throughout. Useful hints given on operation of mobile stations in general.—**QST (U.S.A.), August, 1949, p. 11.**

Simplicity on Six. 75 watts output on 50 mc. with two stages and low-cost components. 6AG7 oscillator doubler (crystal controlled oscillator using 25-27 mc. crystals). 829-B valve as amplifier.—**QST (U.S.A.), August, 1949, p. 40.**

Single Sideband for the Average Ham. Circuit and construction of a one-band exciter. Phasing method of single-sideband generation is employed. Exciter requires R.F. driving power from present exciter, audio power from present speech amplifier, and a power supply. Uses 6V6 valves as balanced modulators.
—**QST (U.S.A.), August, 1949, p. 47.**

MISCELLANEOUS:

Electronics in Meteorology. Description of equipment and techniques: Radiosonde, sferics, ceilometer, and automatic weather station.
—**Radio News (U.S.A.) (Rad. & El. Ed.), Aug., 1949, p. 3.**

The Magnetic Amplifier. Detailed analysis of mode of operation of magnetic amplifiers, and discussion of design features. Advanced circuit theory.
—**Radio News (U.S.A.) (Rad. & El. Ed.), Aug., 1949, p. 14.**

An Inexpensive Photoelectric Burglar Alarm. Circuit and construction of an alarm which, using 2 candle-power bulb in conjunction with a three-inch projection lens, gives range of more than 300 feet. Infra-red filter provides black light operation.
—**Radio News (U.S.A.), September, 1949, p. 44.**

Experimenter's Power Supply. Circuit and construction of a unit giving continuously variable D.C. output from 58-305 volts at 100 ma., and twelve low A.C. output voltages. Two 6L6 valves are used for electronic control of D.C. output voltage.
—**Radio News (U.S.A.), September, 1949, p. 64.**

The Physics of C.R.T. Screens. Description of physical characteristics of screen materials and theoretical concepts of processes involved. List of reference articles provided.
—**Electronic Engineering (Eng.), September, 1949, p. 287.**

The Ad Hoc Committee Report. Report of study group, comprising F.C.C. (U.S.) specialists and others, which inquired into propagation problems involved in F.M. and T.V. transmission between 50 and 250 mc. Report covers: (1) Prediction of field service intensities; (2) evaluation of random variations in field intensity from medium levels due to local terrain and buildings; (3) troposphere propagation on curve evaluation; and (4) Method of combining the effects of the spatial and time variations of the desired signal and one or more interfering signals.—**Communications (U.S.A.), July, 1949, p. 6.**

(Concluded on page 48.)

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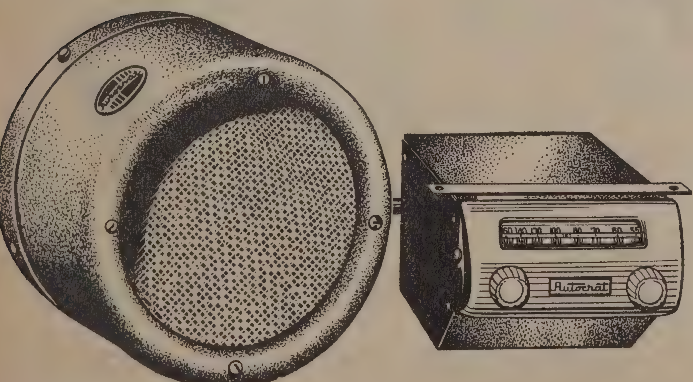

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The Suppression Of Domestic Appliances

By THE TECHNICAL STAFF OF BELLING-LEE, ENGLAND

These notes will be found invaluable by those who have the sometimes unenviable job of installing new sets in locations that are not free from interference. In particular, this article presents, for the first time in this country, information on the suppression of interference from fluorescent lighting.

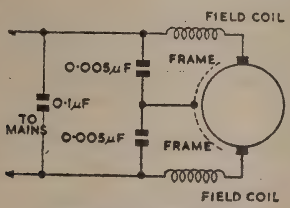
A great many electrical appliances can cause interference with radio reception, but, fortunately, they can be grouped into a small number of categories, and all appliances in each group can be suppressed by the same sort of treatment.

Cheap and effective suppression can often be obtained by connecting suitable capacitors in the right place. Where these alone are inadequate, combinations of capacitors and air-cored inductors usually give satisfactory results.

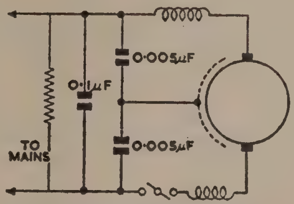
SAFETY

It is necessary to give a word of caution. Many pieces of electrical equipment are classed as "unearthed appliances." Such appliances may well be described as being all those which are connected to the mains by a plug and a socket. These rely on the third pin of a three-pin plug for an earth connection to the metal frame. No reliance can be placed on their always being earthed, since someone may replace the plug by a two-pin version. It cannot be said that these appliances are soundly bonded to earth, and, as a result, strict limits must be placed on the values of capacitors connected between mains leads and the frame of any such appliance.

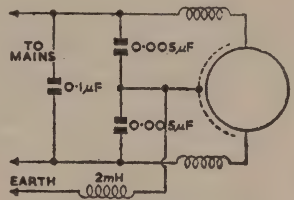
In no circumstances may capacitors totalling more than 0.005 μf. be connected to the frame of an unearthed appliance from either mains lead. Otherwise the user of the appliance may receive an unpleasant, possibly dangerous, shock.



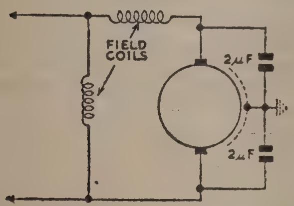
(1) Suppression applied to small commutator motor



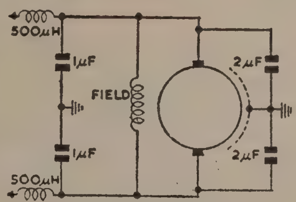
(2) If not switched, filter should be "bled"



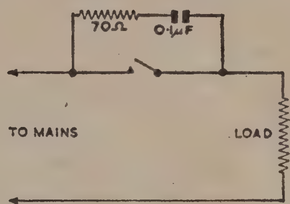
(3) Earth connection made through RF choke



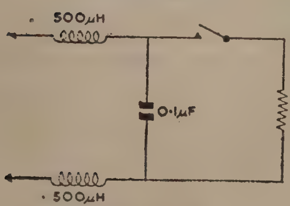
(4) Suppression method applicable to larger machines



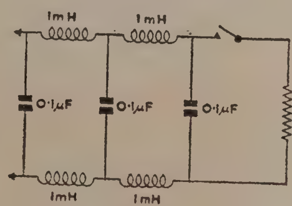
(5) An additional filter is sometimes necessary



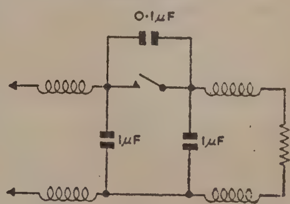
(6) Circuit applicable to contacts controlling a small load



(7) Inductor-capacitor suppression for heavy-duty contact device



(8) Another thermostat or contact suppression circuit



(9) Circuit for use where the load is remote from switch

Capacitors should be carefully chosen, ensuring that they have a low self-inductance, since they must offer a low impedance to radio frequencies. The leads to a capacitor contribute a considerable amount of its self-inductance, and it is essential that the connecting leads always be kept very short. Quite literally, every inch counts.

For equally good reasons, inductors must possess a low distributed capacity, especially when used for suppression work at very high frequencies.

CAPACITOR RATINGS

Under certain conditions of resonance or surge, capacitors used in suppression work are often subjected to voltages which are considerably in excess of the supply voltage. In order to guard against breakdown of the dielectric under these circumstances, it is desirable to use capacitors which are so constructed that they can withstand without detriment the repeated application of about four times the voltage of the supply. This applies particularly to capacitors which are connected to the frame of an appliance. For most work, capacitors rated at 1,000v. D.C. working should be used.

The physical construction of capacitors should always be of such a nature that their inductance is kept low. The "extended foil type" with an impregnated paper dielectric is satisfactory, and can be obtained in convenient tubular packs.

Metal casings are not essential, and are even undesirable in places where the capacitor has to be accommodated in a small space, and where there is a risk of the case touching a live point on the appliance. Needless to say, electrolytic capacitors are wholly unsuitable, and should never be used.

MOTORED APPLIANCES

The first class of appliance comprises those which come under the heading of electric motors. This includes vacuum cleaners, refrigerators, hair-dryers, floor-polishers, and all apparatus employing commutator-type motors. All these can give rise to severe interference, and it is almost true to say that it is the smallest motors which make the most trouble.

Almost all of these can be suppressed by the use of a "delta" capacitor network connected across the mains leads to the motor (Fig. 1). It is essential that this network be placed as close to the motor as possible so that the interconnecting leads may be short.

It is desirable that any switch on the appliance should come between the supply and the capacitors, and not between the capacitors and the motor. If this is not possible, a discharge resistor of approximately one megohm must be fitted (Fig. 2) to avoid the possibility of someone touching the pins of the plug after it has been withdrawn from the mains socket and receiving a shock from the charge on the capacitors.

Most interfering appliances will propagate less interference if no earth connection is taken to the frame. The absence of an earth is undesirable for other reasons, however, and use is sometimes made of an R.F. choke in the earth lead (Fig. 3). If suitably designed, such a choke can afford an adequate path to earth for fault currents and yet offer a high impedance to radio frequencies. Its provision is contrary to certain wiring regulations, but, at the same time, is often the only way to obtain adequate suppression.

An alternative method of suppression of commutator-type motors is the use of capacitors at the brush-gear. Suitably rated capacitors should be connected (Fig. 4) between the brush arms of the motor and its frame, using connections not more than two or three inches in length. The limitation on the size of capacity used on un-earthed appliances must be observed.

This method is not always suitable for small motors, owing to the absence of sufficient space inside the housing for the accommodation of suppressor equipment; it may often be used to advantage, however, on larger machines, when capacitor values up to 2 μf. can be employed, provided the motor is soundly bonded to earth.

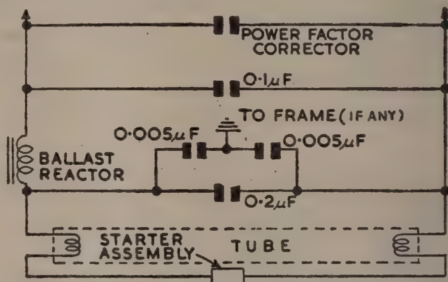
Certain types of motor, particularly variable-speed A.C. motors, may require capacitors at the brushes and also across the supply leads. In extreme cases it may be advantageous to use inductors in addition (Fig. 5).

Motors having four or more poles can often be suppressed by the use of only two capacitors, these being connected between adjacent brush-arms of opposite polarity and the frame of the machine. It is rarely necessary to connect capacitors to each brush-arm.

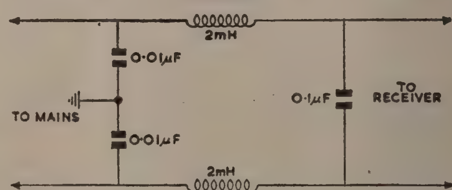
CONTACT DEVICES

Next comes the class of thermostats and frequently operated contacts. Into this category fall thermostatically controlled irons, water heaters, bed-warmers, and such things as flashing signs and infinitely variable controls of the type used to regulate the hot-plates of electric cookers.

Where the load carried by the contacts is small (less than about 100 watts), suppression can often be obtained by shunting the contacts with a resistor and



(10) A circuit to try where a fluorescent lamp causes interference



(11) Filter for insertion in mains lead to a radio set

a capacitor in series (Fig. 6). The values may be of the order of 70 ohms and 0.1 μf. respectively, but these values should be considered as a rough guide only. The values for optimum results in any particular case can only be found by experiment.

Where the load is too large for effective suppression by this method, inductor-capacitor filters must be used, the arrangement being dependent upon the circuit of the appliance to be suppressed. Typical arrangements are shown (Figs. 7, 8) for cases in which the load is close to the controlling contacts and when remote from them (Fig. 9).

IGNITION

Ignition systems on motor-vehicles form a class of their own so far as interference with radio reception is concerned. The remedy is simple, and consists merely of a resistor inserted in the high-tension circuit to damp out the radio frequency oscillations which are normally set up by the spark discharge.

When suppression is required only for the benefit

of those who live beside the roads along which the vehicle is to be driven, one resistor of about 10,000 ohms, in the lead between the coil and the distributor, is sufficient.

When it is desired to operate a receiver on the vehicle, further resistors must be used, one in each plug lead, close to the sparking plug. It may also be necessary to screen the high-tension leads and to use a capacitor suppressor at the contacts in the low-tension circuit.

Other devices on a motor-vehicle which may interfere with a car radio are the dynamo, wind-screen-wiper motor, and voltage regulator. The first two of these can be dealt with by the methods already outlined. If the voltage regulator is of an interfering type, however, suppression may prove difficult, and as such regulators are easily put out of adjustment, it is usually advisable to consult the makers rather than to attempt suppression by methods which may cause expensive damage.

FLUORESCENT LAMPS

A frequent offender nowadays is the fluorescent lamp, although only a small percentage of these lamps cause serious interference. No adequate explanation for the occurrence of this interference is as yet forthcoming, and all that can be said is that it is a function of the lamp itself, and not of its associated circuit.

Most lamps never cause interference, and those that do may not do so until they have been in use for a considerable time. Often the interference may be eliminated by reversing the lamp in its holder, although this may sometimes afford only temporary respite. A cheap and effective method of suppression by small capacitors is shown in Fig. 10.

CONVERTERS AND FURNACES

The majority of appliances in general use have now been covered, and there is little space in which to deal with special considerations. Rotary converters should be treated as motors, but may require inductor-capacitor filters in their outputs, and may also require to be screened. Oil-burning furnaces for domestic hot-water systems have recently become popular, and can often cause havoc with radio and television reception. A combination of the treatments given for motors, thermostats, and ignition systems is called for.

SUPPRESSION AT RECEIVER

Suppression at the receiver, in many cases, may not be possible, but where it can be applied it may be the easiest and cheapest way out of the difficulty.

Interference can reach a receiver in three ways—namely, via the aerial-earth system, via the mains leads, and by direct pick-up on the receiver components. (Concluded on page 47.)

TRADE WINDS

RADIO MANUFACTURERS' ANNUAL CONFERENCE
CHANGE IN LOCATION

There has been an alteration in the plans for the forthcoming annual conference of the New Zealand Radio Manufacturers' Federation which was to have been held in Napier.

This site was found to be unsuitable to the majority of members, and the manufacturers will now meet at the Hotel Wairakei, Wairakei Springs. The dates—Wednesday and Thursday, 7th and 8th December—remain unchanged.

Many important aspects of the radio and electronic industry's activities will be discussed by an expected large number of federation members.

* * *

RADIOS IN DEMAND: NO INCREASE IN PRICES

Radio-set prices and the prices of radio accessories and components should show no upward trends. This was the prediction of Mr. Wm. J. Blackwell, president of the New Zealand Radio Manufacturers' Federation, when commenting recently on the decision of the Government to lift price-control on the radio and electronic industry.

'Lifting of control indicates an appreciation by the authorities of the highly economic and efficient state of the New Zealand industry," said Mr. Blackwell. "The federation has recommended de-control for some time. By friendly though nevertheless intense rivalry among firms, prices of radio sets are extremely competitive, and through the unrelenting efforts of manufacturers to provide the listening public with high-performance sets at most equitable price levels, price-control has become redundant and unnecessary. It is pleasing to see this recognized by the authorities, thus relieving much-wanted clerical staff for more important duties in industry, and, no doubt, in the Public Service."

It was common knowledge in the trade that the current expansion of the New Zealand Broadcasting Service network was stimulating the demand for more sets. Likewise, the desirability for having more than one radio in the home, as was the case in the United States, was becoming generally appreciated by the New Zealand public. This expansion in sales, Mr. Blackwell concluded, was being met by high-quality production in an unprecedented range of models to meet every requirement. The purchasing listener could rest assured that the removal of price-control and the return to a healthy, unfettered, competitive price basis would react, not detrimentally, but definitely to his benefit.

* * *

NEW ZEALAND INDUSTRIES FAIR

Prominent among exhibitors at the highly successful Fair held in Hamilton were the Akrad Radio Corp., Ltd., in conjunction with G. A. Wooller & Co., Ltd.

George Wooller and Tom Spencer were present in their attractive stall during the whole of the Exhibition, and it was crowded continuously, not only with sightseers among the Waikato public but with members of the trade also in large numbers. The stall attracted the attention of the Hon. A. H. Nordmeyer, who made an official visit. Considerable fun was created with their wire recorder.

The Hon. A. H. Nordmeyer visits the stand of G. A. Wooller & Co., Ltd. Reading from left to right are seen: Mr. A. J. Yendell (President, Hamilton Manufacturers' Association), Mr. T. J. Spencer (manager, Akrad Radio), Mr. S. H. Edwards (President, Auckland Manufacturers' Association), Mr. George Wooller, the Hon. A. H. Nordmeyer (Minister of Industries and Commerce). Demonstrating the Regent set is Mr. Don Whisker, of G. A. Wooller & Co., Ltd.

Stand of Akrad Radio Corp., Ltd.

Another attractive exhibit was staged by Radio (1936), Ltd., who had one of the largest stalls in the Fair, making a most attractive display with the wide range of their products.

Industrial Electronics also exhibited and gave demonstrations of communications with taxi-cabs operating in the streets of Hamilton by radio telephone from their stall. This created considerable interest with the public.

* * *

RETIREMENT OF MR. C. W. RICKARD

The C. & A. Odlin Timber and Hardware Co., Ltd., greatly regret to announce the retirement, at his own request, of Mr. C. W. Rickard, after 42 years' valued service.

Interviewing Mr. Rickard recently with regard to this prospect, a representative of "Radio and Electronics" remarked on the loss which would be felt by the radio industry by the retirement of one yet so full of vitality and with so comprehensive a back-

ground of the trade. To this, however, Mr. Rickard smilingly replied that he had had a good innings, and now he felt that the time had come for him to enjoy the other side of life and do the things which hitherto had always to be put aside on account of business ties. Bowls, we suspect, will occupy quite a portion of his time in the summer months, and we gather that travel is also envisaged by this veteran of radio, already well known as a much-travelled man, having visited Great Britain and the Continent several times, besides making five trips to the United States of America and Canada. To his regret, Adelaide, his home town, has not featured much in his travels so far, but we think it safe to say that this matter will be remedied in the near future.

Joining C. & A. Odlin, Ltd., as a traveller in their newly established hardware business in 1908, Mr. Rickard was appointed manager in 1914, and subsequently became a director of the company. Illustrative of his foresight was his appreciation of the possibilities of radio way back in the days of its infancy, and his introduction in his firm of a new radio department which he successfully piloted until the present day.

For his success as a business man, his genial personality and his sterling character, he will long be remembered by all with whom he has been associated. It is no mean feat to be associated with one firm for a period of more than 42 years, and we can appreciate the general regret felt by C. & A. Odlin, Ltd., at the loss of the services of so valued a member.

Our very best wishes go to Mr. Rickard for a long and happy period of retirement.

APPOINTMENT OF MR. JACK OLIVER

We have been advised that Jack Oliver, assistant radio sales manager, will take over the management of the radio department of C. & A. Odlin, Ltd., on the retirement of Mr. C. W. Rickard at the end of 1949. Of retiring personality and pleasing disposition, Jack is popular in the trade, and this appointment, we are sure, will be well received. All our best wishes to you, Jack, for future success.

A PRACTICAL BEGINNER'S COURSE

PART 37: CONSTRUCTING THE 6J7 SHORT WAVE SET (CONTINUED)

COIL WINDINGS

To cover the whole shortwave range, only three coils are needed. Their construction can be seen in the photograph, which shows the middle-sized coil. L_1 is the small winding at the top of the former, while the double-spaced winding is L_2, the grid coil. It should be noted that the **top** of L_2 (on the photograph) is the end which is earthed, the lower end being the one which goes to the tuning condensers. Thus, the tapping is made the specified number of turns from the **top** end of the actual coil, which is the **bottom** end of the coil on the circuit. The windings are as follows:—

Coil A

L_1, 15 turns of 30-gauge enamelled wire, close wound.
L_2, 30 turns of 20-gauge enamelled wire, close wound, ⅛ in. below L_1. The cathode tap is 3 turns down from the top of L_2.

Coil B

L_1, 7 turns of 30-gauge enamelled wire, double spaced.
L_2, 13 turns of 20-gauge enamelled wire, double spaced, ⅛ in. below L_1. The cathode tap is 1½ turns down from the top of L_2.

Coil C

L_1, 4 turns of 30-gauge enamelled wire, double spaced.
L_2, 5¾ turns of 20-gauge enamelled wire, spaced to occupy a length of ⅞ in. on the former, ⅛ in. below L_1. The cathode tap is 1½ turns down from the top of L_2.

Note.—All coils are wound on 1¼ in. diameter formers, which are glued to four-pin valve-base plugs.

MAKING THE COILS

The first step in making the coils is to procure a short length (about a foot) of 1¼ in. diameter bakelized paper tubing, of the kind sold in various diameters for coil formers. Also, we require three plugs to which the former can be glued. These plugs are obtainable with four, five six, or eight pins, and are designed to plug into valve sockets of the American series. Usually, the plugs are fitted with metal covers to protect the wiring as it enters the hollow valve-pins, but these can be discarded, as they will not be needed for our purpose. The 1¼ in. tubing referred to is a neat fit over the black baketlite part of the plugs, and all that is needed to make a very strong union is to flow some very strong glue, such as "Ataglu" or other casein glue, round the joint and let it set for 24 hours. The coil windings can then be put on. The aerial windings, L_1 in the circuit diagram, are put on first, and the leads passed through the appropriate valve pins and soldered into place. Care must be taken to see that the pins on the coil that are used for terminating the windings correspond with the contacts on the coil socket, used when the set was being wired, or the proper connections will not be made when the coils are plugged in. Fortunately, the pins on the plugs are usually numbered, which makes it easier. However, if they are not, one can number them himself in the following way. The plug is held with the pins upward and turned so that the large pins are towards you. Then, call the left-hand large pin No. 1, and number the rest in a clockwise direction. A similar process can be followed for numbering the contacts on the coil socket. This is viewed from **underneath**, with the large holes towards you. Then the left-hand one is numbered "one," and the others are numbered in a clockwise direction as for the plug. Then, it will be certain that when plug and socket are together, contact No. 1 on the socket makes contact with pin No. 1 on the plug, and so on.

As was detailed in the last instalment, the aerial end of L_1 is connected to socket connection No. 3, so that when winding the coil the upper end of L_1 is connected to pin No. 2 on the plug. The earthed end of the aerial winding is connected to pin No. 4.

Now, it is essential not to get the connections to the tuned winding, L_2, wrong; if the wiring to this winding is incorrect, the set will not work, however well it has been made otherwise.

For reasons which we cannot go into at the moment, the actual coil L_2 is wound "upside down" compared with the circuit diagram. The photograph shows one of the coils, with the small aerial winding L_1 at the top of the former. Now, the top of L_2, nearest to L_1, is the earthed end, and is connected to pin No. 4. In the photograph, this contact on the socket can be seen connected to the earth terminal, and from it a second wire goes through a small hole in the chassis just to the left of the switch. This wire is connected to the moving plates of the tuning condensers, which are the ones electrically connected to the frame. In winding L_2, the easiest way to connect the tap which goes to the cathode of the valve is as follows: The small number of turns between the earthed end of the winding and the tap are put on first, and the end taken through a hole in the former to pin No. 2, just as if there were no more turns to go on. Then, a second wire is soldered into pin No. 2, and is taken up through the same hole in the coil former, and the winding is continued until the required total number of turns for L_2 have been put on. The finished appearance is just as if the coil were wound in one piece, and there is then no difficulty of trying to solder a lead to a spot on one turn of a coil that has all been wound.

PUTTING THE SET INTO OPERATION

When one of the coils has been made—preferably coil A—it can be plugged into the set. When this is done, it is a good idea to check through the coil connections to make sure that the actual circuit corresponds with what the circuit diagram says it should be. This will save considerable disappointment should there be an error, since this can be rectified before the set is switched on. When you are sure that all is well, the filament transformer can be connected to the filament leads, and switched on to make sure that the valve heats properly. Next, the B battery can be connected, and the phones plugged in. First of all do not connect an aerial, but investigate the operation without one. This will tell you whether the set itself is functioning properly. There should be the usual slight rushing sound in the headphones when the regeneration control is advanced sufficiently to make the set oscillate. One advantage of the pentode

(Continued on page 26.)

The PHILIPS Experimenter

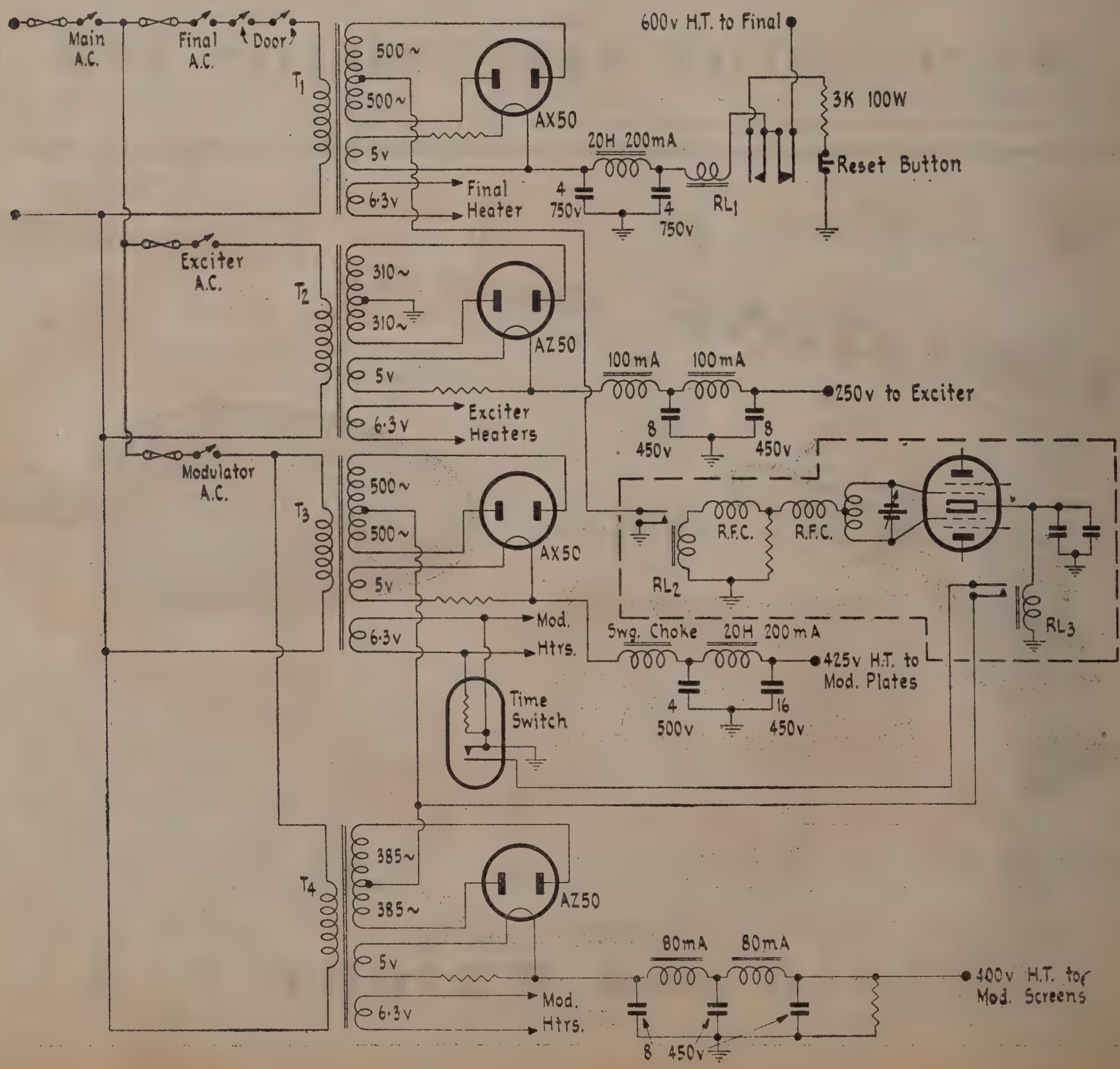
No. 26: COMPLETE POWER SUPPLY AND SEQUENCE-SWITCHING FOR THE PHILIPS 100-WATT TRANSMITTER

As we have described the various main parts of the 100-watt transmitter, we have given the power supply circuits for only the modulator, since this is somewhat out of the ordinary in using separate supplies for the plates and screens. We have also indicated that the transmitter would include circuit protection in the form of sequence-switching, together with an overload relay whose purpose it is to remove the H.T. from the final amplifier in the event of a fault causing this stage to draw more than it is designed to do. Many amateurs make no provision for protective circuitry of this nature—partly, we think, because the amateur literature does not enlarge upon it to any great extent and partly because it is considered to be unnecessary expense that does not add anything to the output or efficiency of the transmitter.

We, however, do not subscribe to this view.

THE POWER SUPPLIES PROPER

There are four separate transformer-rectifier combinations altogether. Two of these have already been described in the section dealing with the modulation system. The remaining two are for the exciter and the final amplifier respectively. At first glance, this might seem an unnecessarily large quantity of power equipment, and that it would be more costly than



usual. This is not so, however, because the two large supplies for the final amplifier and the modulator plates use transformers of 500 volts-a-side at 200 ma. Readers will agree that it is not often that a 100-watt transmitter is seen which does not include a transformer with a secondary voltage higher than 500 volts A.C. The reason why we are able to do this, of course, lies in the choice of valves both for the modulator stage and for the modulated amplifier. The QQE06/40, working as it does at only 600 volts, eliminates the usual 750 or 1000-volt transformer, and results in power supply economy which offsets to a large extent the extra cost of providing a valve like this one, compared with the use of one or two cheaper ones of inferior characteristics.

The final power supply, at the top of the circuit diagram, uses a standard 500v. 200 ma. power transformer, with an AX50 mercury vapour rectifier and a condenser input filter system of one section only. This supply feeds both plates and screen of the QQE06/40. At the output of the filter is seen the overload relay and its circuit, of which more anon.

The next supply, from T_2, is for the exciter, and is nothing more than a medium-sized receiving power supply. Choke input is used here, because there are no standard power transformers of the required current rating which have a low enough output voltage to allow condenser input to be used. Also, the use of choke input helps to give the supply better regulation. In the case of the exciter unit, this is of some importance, because the current drain changes considerably from time to time, according to how many of the multipliers are in circuit.

It will be noted that a 100 ma. transformer has been specified in this supply. This is suitable when the QQE06/40 final stage is used, because only one QV04/7 is then needed in the driver stage. If it is decided to use the parallel pair of QV04/7's, in order to drive a triode final, it would be advisable to increase the rating of the transformer and chokes of this supply to 150 ma. to take care of the additional current drain. The two lower power supplies, together with the vacuum time-delay switch, have already been described.

SEQUENCE-SWITCHING AND PROTECTIVE SYSTEM

At the top left-hand corner of the diagram is the A.C. input to the power supply chassis. The first component is a main fuse, and this is followed by a main A.C. switch. When this is off, no A.C. can be applied to any part of the transmitter. Next, we have in parallel with the main supply leads the primaries of all four power supplies. Each supply has its own fuse, with the exception of the modulator screen supply, which is grouped with the modulator plate supply for fusing purposes. In order to explain the operation of the various relays, we will go through the starting-up sequence in detail.

First of all, we will assume that the transmitter

(Continued on page 28.)

A PRACTICAL BEGINNERS' COURSE

(Continued from page 22.)

detector with the screen voltage varied to control the reaction is the extremely smooth way in which the circuit comes in and out of oscillation. If the set has been built according to instructions, there will be no "plops" as the oscillation commences, but there should be a gradual transition from the oscillating to the non-oscillating condition, and vice versa, as the screen potentiometer is manipulated. It is thus very easy to set the receiver just to the point of greatest sensitivity, which is just before oscillation commences. There should be no need by now to tell readers how to tune in a regenerative set, but we would like to impress upon everyone that more care is needed to get good results out of a shortwave set than from a broadcast set of the same kind. However, this is mostly taken care of by the provision of the bandspread condenser, which makes the shortwave stations particularly easy to tune. The metal chassis construction will be recognized, too, as a great advance on the "breadboard" type of make-up, because there will be no trouble from hand-capacity, and because the extra rigidity of the whole set makes it almost impossible to lose a weak station due to the wiring moving slightly when the hand is removed from the tuning knob. The best way to use the two tuning condensers is to search carefully with the 100 $\mu\mu$f. condenser, or band-setting condenser, with the set just above oscillating and no more. When a collection of phone stations is met, as one travels slowly across the dial, it will be recognized by the number of steady whistles as the dial is turned slightly. This will probably be one of the shortwave broadcast bands, or an amateur transmitting band.

When such a collection of stations is found, stop tuning with the band-setting condenser and go over to the bandspread condenser. Now, careful tuning will enable the individual stations to be picked out quite easily, and backing off the reaction till the set is just not oscillating will bring in the signal "loud and clear." We have recommended the use of the A coil first because on it, near the full-in position of the band-setting condenser, will be found the 80-metre amateur band, which every evening is a mass of signals of different strengths. It is the best place on the dial to use in becoming familiar with the peculiarities of the set and learning to work it to the best advantage.

So far we have not given any reason for our recommendation not to attach the aerial at first when testing the set. The reason is this: When an aerial

is connected directly to a regenerative detector, as here, it can cause wide differences in the setting of the reaction control because of the way in which it loads the detector circuit more at some frequencies than at others. Thus, if the aerial is connected, and it is found that oscillation is not possible to obtain at some settings of the tuning condenser, it does not mean that there is anything wrong with the set. Without the aerial attached, it will be found as a regular thing that a little more reaction—i.e., more screen voltage in this case, is needed at the full-in setting of the mian tuning condenser than at the other end of the dial. This is quite normal, and with this circuit the difference in the setting of the reaction control should not change very much as the tuning condenser is varied. If a too large difference is found, or if it is difficult **without an aerial** to get oscillation over the whole dial, then all that needs to be done is to take the cathode tap on L_2 a little nearer the grid end of the coil. On coils B and C, however, this should be done very carefully, if at all, because a different trouble occurs if the tap is too far towards the grid end of the winding.

The purpose of the aerial series trimmer is to allow the set to oscillate at all tuning condenser settings after the aerial has been connected. Different aerials will cause oscillation to stop at different points on the dial, so that no fixed recommendations can be made. However, the trimmer is used in this way. If a point is reached at which the set will no longer oscillate, all that has to be done is to reduce the capacity of the aerial trimmer. This will allow oscillation at the spot we are interested in, but will shift the "dead spot" to another part of the dial. The rule is to use as much capacity as possible in the aerial trimmer as long as oscillation can still be obtained. This behaviour is quite normal with a shortwave set of this kind, and is a very strong reason for adding a stage of R.F. amplification ahead of the detector, because, when this is done, all "dead spot" trouble is automatically eliminated, because the aerial is no longer directly attached to the detector.

You will soon get into the way of operating the set, and if it has been carefully built there will be no difficulty in receiving broadcast and amateur signals from all parts of the world. So much so that you might wonder why we go to so much trouble to produce vastly more complicated sets at all.

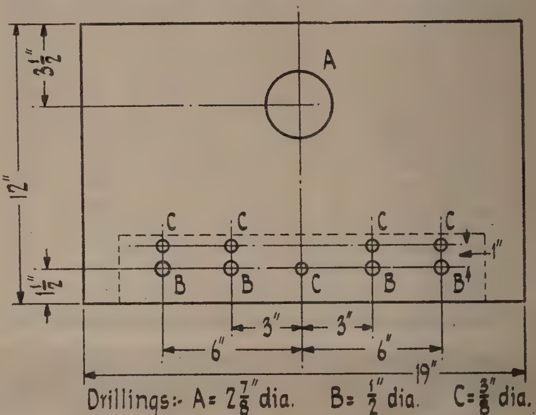
PHILIPS EXPERIMENTER

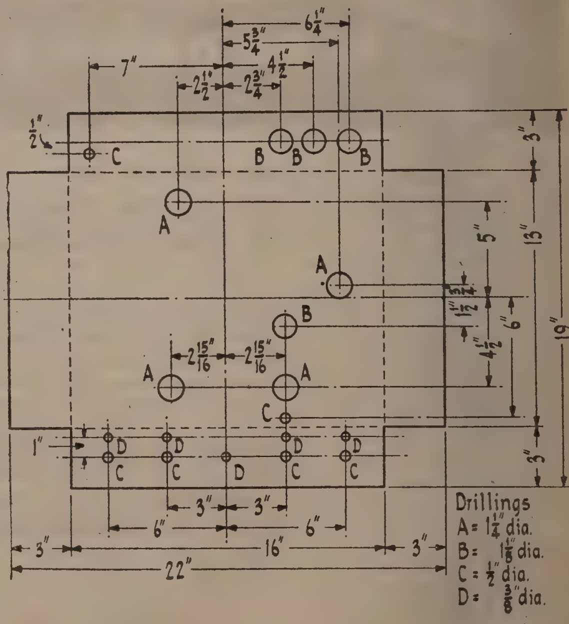
(Continued from page 25.)

has previously been on, and that it is properly in tune on one of the bands. Also, that the V.F.O. has been switched on.

The first operation is, of course, to turn on the main A.C. switch. This done, the final amplifier and exciter supplies are switched on simultaneously. When this is done, the exciter and final amplifier's heaters come on, so that by the time the exciter has warmed up the final heater is also warm, and the final presents a load for the exciter's output stage. The final H.T. supply does not come on, however, because, although the transformer is turned on and the rectifier is warm, the final's transformer's centre-tap is disconnected from earth. This is because the relay, RL_2, has not yet been operated and its contacts are open. This relay is in the grid circuit of the final, so that it closes only when the final is drawing grid current. By this means, as soon as the exciter has warmed up, the relay operates and H.T. is immediately applied to the final through the normally closed contacts of RL_1, the overload relay. At this point, the final draws plate current, and, if the final is properly loaded by the aerial, this current is sufficient to close a third relay, RL_3, in its cathode circuit. This relay's contacts are normally open, and since they are connected in the centre-tap earth-return circuit of the modulator plate and screen transformers no H.T. can be applied to the modulator until the final is drawing a good and sufficient cathode current, whose value depends on the setting of the relay, RL_3. Finally, the modulator A.C. switch is turned on, and the time-delay relay commences to warm up. By the time its contacts close, both plate and screen supplies for the modulator and the modulator heaters have warmed up, so that the moment the time-delay closes, plate and screen supplies are simultaneously applied to the modulator and the transmitter is fully on the air.

From the above description, it can be seen (1) that





Chassis and panel for power supplies

if all A.C. switches are turned on at once, the final amplifier H.T. cannot be applied until the tube is drawing grid current and the modulator H.T. cannot be applied until the final is drawing current and presenting a load for it. This protects the final from

(Concluded on page 48.)

Multivibrators For Pleasure and Profit

For those experimenters who have felt the need for some interesting circuits with which to "play" and which are right away from the average audio or radio frequency circuit with which all are familiar, the multivibrator offers considerable scope for ingenuity in application. Here is an account of some of the things that can be done with them, and some practical circuits for doing them.

(1) SLOW-SPEED SWITCHING

The multivibrator is a versatile device. For those who are not familiar with it, perhaps we should describe it first. The circuit of a simple triode multivibrator is given in Fig. 1, from which it can be seen that the circuit is nothing more than a pair of resistance-capacity-coupled amplifiers, the output of each being applied to the input of the other. Without going deeply into technicalities, it can be seen at a glance that such a system of valves will oscillate in some way or other, since if we imagine a signal as being applied to either grid, we find that, after passing through both valves and having been considerably

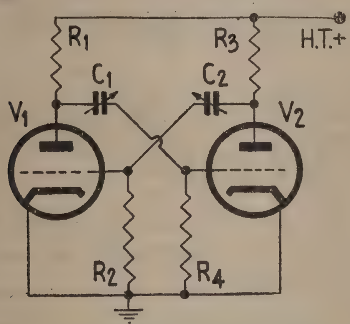


Fig. 1.—Basic triode multivibrator circuit

amplified on the way, this signal is re-applied to the same grid. Furthermore, it is in the same polarity as when it started, so that the whole arrangement is very highly regenerative, and must oscillate in some manner or other. This much is very easy to see, but simply by looking at the circuit it is not at all obvious that the oscillation, once set up, should have any particular frequency, because there are no tuned circuits anywhere. Nor is it obvious what sort of waveshape we can expect from such an arrangement.

Again without going into lengthy technical explanations, since the purpose of this article is mainly practical, the output of the multivibrator is what is known as a square-wave. That is to say, it has the shape illustrated in Fig. 2. The term is a little misleading, and a better name would perhaps be a rectangular wave, because the pattern is only approximately square when the amplitude, or output voltage, is such that the horizontal portions are the same length as the vertical portions. The term "square" refers really to the shape of the corners, which are almost exactly right-angles under favourable conditions. Under less favourable conditions, the shape degenerates so that the corners are rounded, or in such a way that the vertical portions of the wave have sloping sides, or both these things can occur at the same time. In any case, the name "square wave" is simply a convenient tag for this general sort of waveshape, in order to distinguish it from others, such as sine-waves, triangular waves, and saw-tooth waves.

It will be seen that each valve is conducting part of the time, and cut right off for part of the time, and it is this behaviour that makes the multivibrator waveform so useful for performing operations that cannot be done with signals of more regular shape, such as sine-waves. In particular, the square-wave output of a multivibrator is ideal if we wish to operate a relay periodically and automatically. In this case, all we have to do is to place the relay coil in the plate circuit of one of the valves instead of the load resistor, as drawn in the diagram. If this is done, the relay will operate during the periods when the tube to which it is connected is passing plate current, and will be released when the same tube is cut off. The relay will therefore be turned on and off automati-

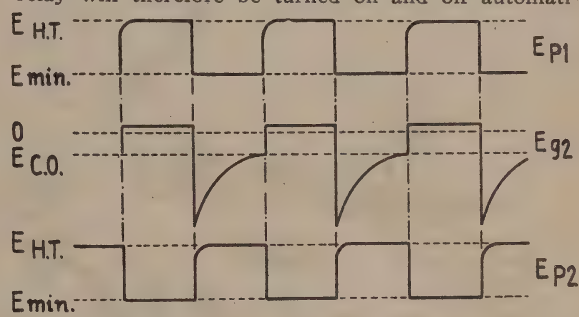


Fig. 2.—Waveforms obtained when the values in Fig. 1 are symmetrical—i.e., $R_1 = R_3$, $R_2 = R_4$, and $C_1 = C_2$. Note that each tube conducts for half the time, and is cut off for the rest of the cycle. Also, when V_1 is conducting, V_2 is cut off, and vice versa. The frequency of oscillation depends mainly on the values of the grid resistors and the coupling condensers.

cally at a rate which depends on the frequency of oscillation of the multivibrator. Now, if the multivibrator is producing a wave-shape like that of Fig. 2, the relay will be "on" for half the time and "off" for the other half. But it may be desired to have the relay working for some different fraction of the time. Should this be so, it can be arranged quite easily by changing some of the values in the multivibrator circuit. Similarly, if the rate at which the relay is to be turned on and off needs to be changed, this also can be done by a simple circuit change. For both these operations, there is no reason why continuous variation should not be had, simply by placing potentiometers in strategic positions in the circuit. Also, if very wide variations of frequency are needed, these can be had by switching in different condenser values. From this short description, it can be seen that quite a wide variety of automatic operations can be performed with the aid of a single relay and multivibrator, with the result that a very large number of "tricks" can be done, using the relay to initiate different operations.

SOME OF THE "TRICKS"

Suppose first of all that we have a multivibrator circuit, built with a relay in the plate circuit of one of the valves, as we have described, and let us see what can be done with such a unit.

One of the first applications that spring to mind is that of automatically switching lights on and off. If the relay is a simple type, with a single make-and-break contact, the device can be used to switch a light on and off at any rate we choose. There could scarcely be a simpler arrangement than this, and yet it can be made the basis of a simple window display in which an intermittent illumination is used to draw the attention of the passer-by. By means of one control, the rate of swiching on and off can be varied to suit the requirements of the moment. It is a simple matter to arrange that the light shall be on for any desired number of seconds, and off for any other number of seconds, and the controls necessary for fixing or altering these times can be built into the multivibrator chassis, so that changes can be made at any time by the operator. For example, suppose that it is decided to have the light (or lights) on for three seconds and off for one second. In this case, the complete cycle of events takes four seconds, so that the rate of operation, or frequency of oscillation (which is the same thing), must be one cycle every four seconds. This can easily be adjusted by means of a frequency control. However, if we wished to have the lights on for two seconds and off for two seconds, the cycle would still occupy four seconds, and the oscillation frequency would be the same as before. How, then, can we arrange for these different ratios between the "on" and "off" times? Simply by adding a separate control, which varies what is known as the mark/space ratio of the multivibrator cycle. **The mark/space ratio is the ratio between the time during which either valve is conducting and the time during which the same valve is cut off.** It can also be controlled by a separate knob to the one which varies the frequency of oscillation. In the first example above, the mark/space ratio would be 3 to 1, and

in the second 1 to 1. The control which varies the mark/space ratio can be made to work quite independently of the frequency control, and can be made to give a very wide variation. By putting this control hard over in either direction, we can make the relay stay open all the time, or stay operated all the time, so that we can have continuous variation between these extremes simply by turning a knob, just as we can vary the switching rate over quite a wide range by means of a frequency control knob.

The very simple case we have just described by no means exhausts the possibilities of the multivibrator circuit for switching lamps on and off. Suppose, for example, that our relay, instead of having a simple make-and-break contact, has change-over contacts instead. That is to say, one pair of contacts are made when the relay is not energized but are broken when it operates, and at the same time another pair of contacts are broken when the relay is not energized and are made when it operates. In other words, the relay, instead of being just a simple on/off switch, is a single-pole double-throw switch instead. This introduces no complications into the multivibrator circuit, which can stay the same as before, but enables a number of different things to be done. For example, to take the simple case of light switching, we can now arrange for one set of lights to be on while a second set is off, so that the multivibrator switches the first set on and the second set off in the same operation, and then completes the cycle of events by switching the second set on and the first set off. This simple scheme could also be used as the basis of a lighting display.

Then there is the possibility of using the relay to operate small electric motors instead of lamps. This is quite an interesting one, and there is almost no limit to the things that can be done in this way.

For example, a relay with change-over contacts can be used to reverse the direction of rotation of a single small motor, such as the 'Electrotor." This can be done at any desired rate, as before, by varying the multivibrator frequency, and, as before, the duration of the runs in the different directions can be controlled by altering the mark/space ratio of the multivibrator. For example, an effective display could be made from a model electric train, complete with track, tunnels, etc., and the multivibrator could be used either to stop the train for a period and start it off again, or else to reverse it. If other simultaneous operations are wanted, the system has possibilities for this, too, because we can place a relay in each of the multivibrator valve's plate circuits, and use the second relay to perform light switching or any other operation at the same time as the main switching operations take place.

PRACTICAL CIRCUIT

A practical circuit for performing the operations we have been describing is shown in Fig. 3. This shows a multivibrator circuit comprising two 6V6's. Here, the multivibrator action is sustained between the screens and the control grids, while the relay is placed in the plate circuit. In this way, the multivibrator action and the relay operation are isolated from each other in a useful way without adding very much complication. In particular, this connection enables the current through the relay to be controlled without sensible effect on the multivibrator action. The usefulness of this is apparent when it is realized that in most cases it will be necessary to use any relay that is available and not to choose a relay for its suitability. Large numbers of fairly insensitive relays are available from surplus ZC1 stocks, and so are 24-volt aircraft relays of varying sensitivities. Sometimes, P. and T. type relays are available, and new ones can certainly be purchased from firms who specialize in relays. Thus, a circuit that can be adjusted to suit a number of different relay types is a distinct advantage.

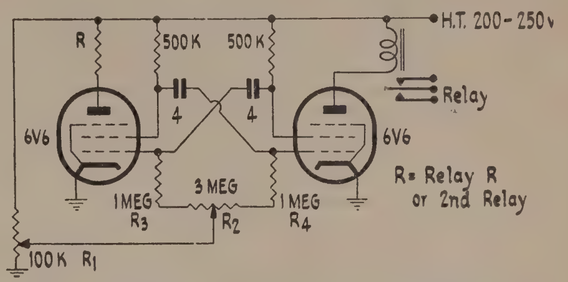


Fig. 3.—Practical circuit for a low-frequency multivibrator that can be used for switching lights on and off for pre-determined intervals, or for doing any desired work that the relay can initiate. Note that the resistor, R, should have the same resistance as that of the relay. A second relay can be placed in the plate circuit of the other valve, if desired.

It will be noticed that the screen resistors are quite high in value. This limits the plate current of the tube during the conducting period. In the circuit of Fig. 3 the plate current of each tube is 12 to 15 ma. while conducting, and since, only one tube conducts at a time, the total H.T. drain is also 12 to 15 ma., which is quite light, and is ample when a relay is used which pulls in at a current of 9 or 10 ma. through its coil. Should a relay be used which takes more current to operate it, the screen resistors can be decreased until the required plate current is drawn, and the screen resistors can be increased if a more sensitive relay is used, so that the current will not be great enough to over-heat it.

The circuit of Fig. 3 is arranged to have a slow oscillation frequency suitable for lamp switching. With the constants shown, and the frequency control, R_1, at the earthed end of its travel, the complete cycle takes approximately 30 seconds to complete. If faster periods are wanted, the frequency control will give a variation from 30 seconds per cycle to about 8 seconds per cycle. If longer or shorter cycles are wanted, these can easily be obtained by changing the values of the condensers connected between the screens and control grids. Changes made in these condensers will give proportional changes in the times obtained. For instance, if they are reduced from 4 μf. to 1 μf., the frequency range will now be from 7.5 seconds per cycle at the low-frequency end of R_1 to 2 seconds per cycle at the high-frequency end of the control.

The second control, R_2, is used to vary the mark/space ratio, as described above. If this control is central, then the resistances in each grid circuit are equal, and the ratio will be 1 to 1, as would be expected. Varying the control to its extreme position at either end, gives a ratio of about 4 to 1. At one end the relay will be closed for one-fifth of the time and open

for four-fifths of the time. At the other end, the situation is reversed and the relay is closed for four-fifths of the time and open for one-fifth. With the constants shown, the time of one complete cycle is almost independent of the position of the mark/space ratio control. It is possible to have a greater range of control over the mark/space ratio by making the fixed grid resistors smaller compared with the variable part, but if this is done the rate of oscillation tends to increase as the mark/space ratio control is moved towards its extreme positions. Limiting the range of control like this makes the two things controllable quite independently of each other. We have shown a 3 meg. potentiometer as R_2, but these are not always available, and it will often be necessary to use a smaller value. For instance, if a 1 meg. pot. is the largest that can be obtained, this will have to be used. Then, in order to preserve the same control over the mark/space ratio, the fixed portions of the grid resistance will have to be lowered to 300 k. Now, unfortunately, doing this will raise the frequency, and, since we have lowered the resistors in the grid circuit by a factor of 3, the frequency will group also by a factor of 3, so that, if it is desired to keep the frequency the same as before, we will have to **increase** the value of the coupling condensers by a similar factor. There is nothing critical about the working of the multivibrator, and if changes are made in the values of the grid resistors and coupling condensers, all that can happen is an alteration in the oscillation frequency. The values we have shown are therefore by way of illustration only, so that they can be juggled to suit the components that are available, within limits. In the circuit of Fig. 3, we have purposely kept the resistors high in value, because doing so enables the very low frequencies that we need for this sort of switching to be obtained with only comparatively small condensers. If alteration of the mark/space ratio is not required to be continuous, very high values of resistor can be used, and this enables ridiculously low switching frequencies to be obtained. For example, in our sample circuit, the total grid circuit resistance is 5 megs., but there is no reason why it should not be raised to 20 megs. In this case, with the 4 μf. condensers, the frequency of oscillation would be one cycle every two minutes at the low-frequency end of the control, R_1, and one every 32 seconds at the high-frequency end. If the condenser sizes were now doubled, these times would be doubled also. In fact, if very large condensers and resistances are used, there is no difficulty in getting frequencies as low as one every 20 minutes!

(Concluded on page 48.)

"RADIO AND ELECTRONICS"

Back and current numbers of "Radio and Electronics" may be obtained from—

Te Aro Book Depot, Courtenay Place, Wellington.
S.O.S. Radio, Ltd., 283 Queen Street, Auckland.
S.O.S. Radio, Ltd., 1 Ward Street, Hamilton.
Tricity House, 209 Manchester St., Christchurch.
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RADIO CONTROL OF MODELS

By L. H. WRIGHT

PART 2: CONTROL MECHANISMS

Some time ago I described in detail the construction of a suitable receiver to operate a relay, and, as was explained at the time, this is only half of the story. The relay is merely an intermediate device to set in motion sufficient power to actuate control movements on the model. This movement can derive its power from separate batteries, spring tension, etc.,

and it is the purpose of this article to review the simplest methods used and describe a practical rudder control unit.

To control the direction of any working model is usually the most desirable, and I list rudder movement as the most important. To stop, start, and control the speed of a model in conjunction with rudder is second in my choice. To be able to also control elevators in the case of model aircraft and possibly raise and lower the landing wheels would be very impressive, but I must call a halt to such wishful thinking and state here and now that the prospective builder is strongly advised to concentrate on only one control to begin with. Because one has succeeded in getting the radio and relay to work 100 per cent. on the test bench, to contemplate the use of selectors to give multiple control is simply asking for trouble before sufficient experience is gained to get only one action completely reliable first. Believe me, it is hard enough in its simplest form, and it is surprising how many things can go wrong. Remember, you model aeroplane fans, if just one small thing fails, it is usually a write-off. So, with this advice off my chest, let us see how means can be found of translating relay movement into rudder action and how to differentiate between left, neutral, and right with but a single relay.

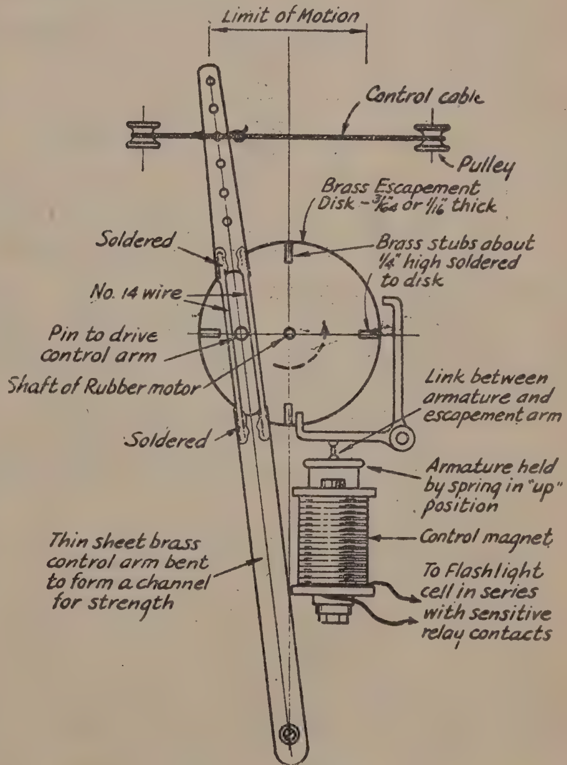
Away back in 1937, when Ross A. Hull constructed his controlled sailplane, he suggested a very simple and practical method of rudder control. He used an escapement in which a rubber band driven wheel was released and allowed to turn a quarter of a revolution each time the transmitter key was pressed and released. Reference to the diagram will show that this wheel swings a pivoted arm which is connected to the rudder horn by thin cotton threads running over two pulleys.

The action is as follows: Each time the transmitter key is pressed and released, the relay in the model immediately follows suit. The relay, being wired in series with a battery to an electro-magnet on the escapement retaining arm, releases the rubber band driven wheel. Due to the shape of the retaining arm, this wheel rotates through only 90 degrees and stops. By pressing and releasing the key again, the wheel rotates a further 90 degrees of its circle. The pivoted arm, actuated by the wheel, swings through the definite limits and the rudder moves accordingly. So that, by pressing and releasing four separate times, it will be seen that a sequence is set up in which the rudder swings from—

(1) Neutral to right;
(2) Right to neutral;
(3) Neutral to left;
(4) Left to neutral;

and so on.

Thus we have a method of securing definite rudder locations from a rotating shaft, and as long as the operator memorizes the sequence of events he knows what will happen each time the transmitter key is pressed and released.



Escapement mechanism of Hull, reproduced from his original QST article.

The seemingly obvious disadvantage of appearing to do continual figure of 8's is no real trouble, as in practice it is easy to waste an unwanted movement by pressing the key twice in quick succession. In the

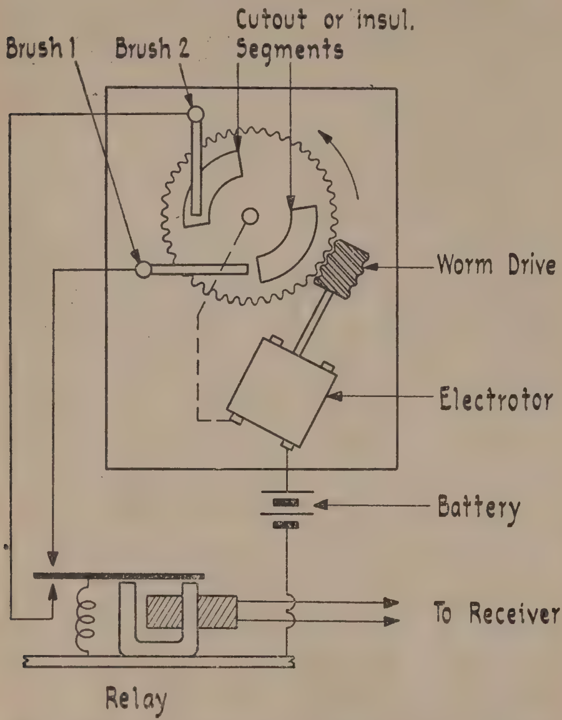
case of a model boat or plane, no appreciable swing is noticed when the rudder flicks over its unwanted movement. This escapement principle has in its favour its extreme simplicity and consequent reliability.

Its disadvantages are—

(1) The rubber motor is liable to run down after a certain number of operations and its power continually decreases.

(2) The individual positions of the rudder are definitely fixed, and no varying degree of control can be made.

(3) The power available is strictly limited, and in the case of a high-speed boat some form of balanced rudder is essential.



Mr. Wright's motor-driven actuator. Not shown is the cranked under-portion of the gear's shaft. The crank operates the control wires or push-rod directly.

Before going further, if the reader does decide to build this unit for the control of a sailplane or model aeroplane, it is advisable to incorporate some form of air brake to the escapement wheel. As a suggestion, a thin sheet of light balsa wood mounted on the wheel spindle is ideal. The idea is to prevent the wheel from gaining too much speed and jumping the escapement stops.

In an effort to simplify control still further and overcome most of the inherent troubles of the above system, the writer uses a small electric motor driven unit, the complete weight of which is just over one ounce. It is small and yet powerful enough to operate any form of control action. It uses considerably less current than the escapement method, with a consequent reduction of battery weight. Although giving definite limit position for the rudder, it is also possible to give varying degrees of movement.

A small D.C. motor (they are available in New Zealand) is mounted on a base and drives via a worm wheel a large gear wheel with almost 120 teeth. This gear has cut-out or insulated segments (see diagram). Two simple bronze contact strips, set at right-angles, bear down on the wheel in the same circle as the segments. These are so arranged and wired that the running of the small motor can be controlled by either of the two wiping brush contacts on the large gear.

A double-acting or two-throw relay is necessary, the two contacts of which are wired directly to the two brushes. A small 3 or 4-volt battery is connected as shown in the diagram. Three penlight cells wired in series are quite suitable.

To describe the action, the relay closes, which allows current to flow through brush No. 1 to start the motor. This continues to run, driving the gear wheel, until Brush No. 1 meets a cut-out or insulated segment, when the motor stops. The relay is opened when Brush No. 2, now in contact with the gear, causes the motor to again start and run until brush No. 2 meets an insulated segment. It stops again. And so, to press the transmitter key, the gear wheel rotates a quarter of a turn, and to release the key it rotates a further quarter-turn. Another press and release and the wheel has made a complete revolution.

A Bell crank fixed to the wheel spindle, with a push

(Continued on page 47.)

TUBE DATA: A NEW TRIODE-HEXODE FREQUENCY CONVERTER.

This new converter valve, which has outstanding characteristics and performance, will be continuously available in New Zealand, as it is being manufactured in Australia by the Amalgamated Wireless Valve Pty., Ltd., to whom we are indebted for the following data and characteristic curves.

TYPE X61M

(Tentative Data)

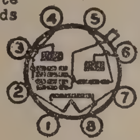
Heater

Voltage	6.3	a.c or d.c. volts
Current	0.3	amp.

Direct Interelectrode Capacitances:

Hexode Grid No. 1 to Cathode (Earth)	5.0 μμF
Hexode Grid No. 1 to Triode Grid	0.27 μμF
Triode Grid to Cathode (Earth)	11.0 μμF
Triode Plate to Cathode (Earth)	7.1 μμF
Hexode Grid No. 1 to Plate	0.085 μμF
Triode Grid to Triode Plate	2.3 μμF
Plate to Cathode (Earth)	14.1 μμF
Maximum Overall Length	4-1/2"
Maximum Diameter	1-17/32"
Base	Wafer Octal 8-pin

Pin 1 - External Shield	Pin 5 - Hexode Grid #3 and Triode Grid
Pin 2 - Heater	Pin 6 - Triode Plate
Pin 3 - Hexode Plate	Pin 7 - Heater
Pin 4 - Hexode Grids #2 and #4	Pin 8 - Cathode
	Cap - Hexode Grid #1



BOTTOM VIEW

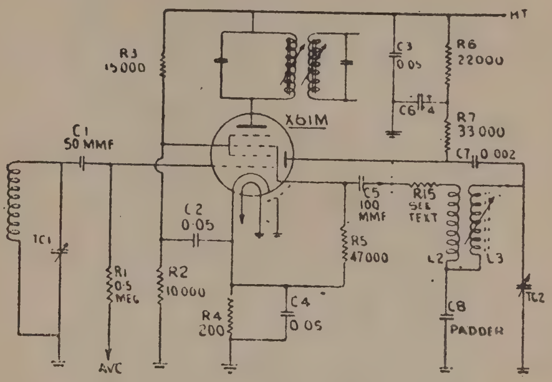


FIG 1

CONVERTER SERVICE

Hexode Plate Voltage	250 max.	volts
Hexode Screen (Grid Nos. 2 and 4) Voltage	100 max.	volts
Hexode Control Grid (Grid No. 1) Voltage	-2 min.	volts
Triode Plate Supply Voltage	250 max.	volts *
Maximum Operating Frequency	60	Mc/s

Typical Operation

Heater Voltage	6.3	6.3	volts
Hexode Plate Voltage	250	250	volts
Hexode Screen Voltage	85	100	volts
Hexode Control Grid Voltage	-2	-3	volts
Triode Plate Voltage	250	250	volts *
Oscillator Grid Voltage (optimum peak)	15	15	volts
Conversion Transconductance	750	620	μmhos
Hexode Control Grid Bias for Conversion Transconductance = 5 μmhos	-	-25	volts
Hexode Plate Current		3.7	mA.
Hexode Screen Current		2.8	mA.
Oscillator Plate Current		3.5	mA.
Cathode Current		10	mA.

* Applied through a 30,000 min. ohm dropping resistor

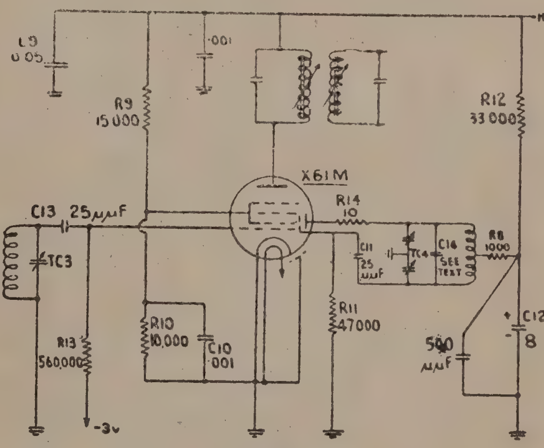


FIG. 2

COLPITTS OSCILLATOR FOR UHF RECEPTION

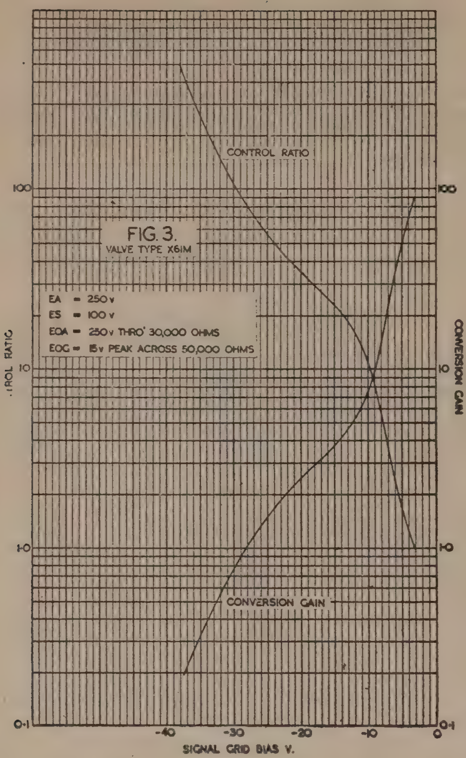
APPLICATION NOTES FOR TYPE X61M

The recommended circuit is shown in Fig. 1. The degree of coupling between the control grid and the tuned circuit may be varied by the condenser, C_1. For shortwave operation a fairly small capacitance is preferred, so that damping, due to the input resistance, is reduced.

The screen grid should be supplied from a low impedance potentiometer, and not via a series resistance from the plate supply; the latter method will extend the control grid base considerably and reduces the control provided by the A.V.C. circuit; the effect of this is to overload the I.F. amplifier. Furthermore, comparatively small changes in screen current will cause wide changes in the plate resistance, which will affect the plate circuit considerably.

The oscillator circuit is quite conventional. In the interests of stability a tuned anode circuit is recommended and is shown in Fig. 1, although the usual tuned grid circuit is satisfactory for many uses. If parasitic oscillation occurs at the high-frequency end of the waveband, the incorporation of a resistance, R_{15}, will reduce the coupling and suppress the parasitic oscillation. The value of the resistance will vary between 25 ohms at 30 mc/s. to 5000 ohms at, say, 300 kc/s.

The curves of Fig. 3 show the variation of conversion gain and control ratio with bias voltage on the signal grid. The control ratio refers to the gain at — 3 volts bias.



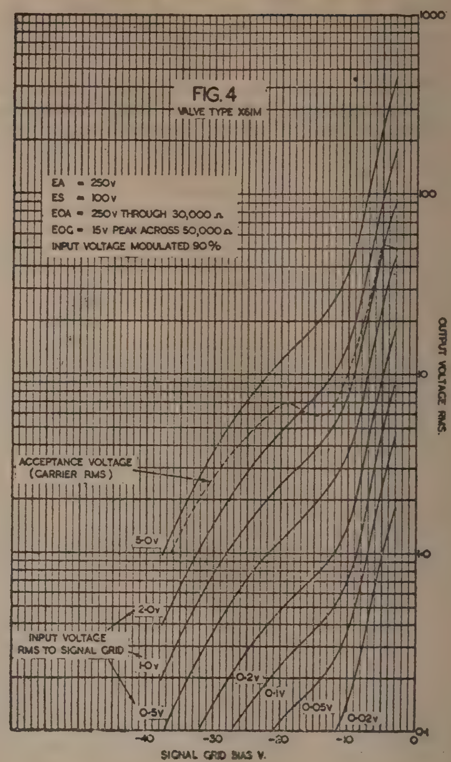


Figure 5 shows the acceptance curve; this curve indicates the R.M.S. carrier voltage which the X61M will handle without giving more than 1 per cent. distortion of the modulation envelope, when the carrier is modulated to 90 per cent.

Although the screen voltage is shown as fixed at 100 volts on Fig. 4 and Fig. 6, the screen was supplied from a 15,000-ohm and 10,000-ohm voltage divider connected across the H.T. supply, as shown in Fig. 1. With this arrangement full A.V.C. must be applied to the X61M to give good control and also to allow the acceptance of large signals.

The input capacitance is reduced by a total of 1.5 $\mu\mu$f., as bias on the signal grid is increased from — 3v. to cut-off. This variation is normally unimportant.

The X61M may be used with its heater either in parallel or in series with other valves of suitable voltage or current rating.

At frequencies above 30 mc/s. the usual oscillator circuit is not as satisfactory as the Colpitts circuit shown in Fig. 2; a two-gang condenser is employed and the circuit is completely symmetrical; oscillation is easy to obtain up to 60 mc/s. and operation above this frequency can be maintained. The degree of coupling to the grid is adjusted by the condenser, C_{11}. If a fairly wide frequency coverage is desired, a resistance, R_{14}, of 5 or 10 ohms may be included to suppress parasitic oscillations as the tuning capacitance is reduced. It will be seen that no self-bias resistance is included; this enables the cathode lead to be kept short. The control grid is returned to a point 2 or 3 volts negative to the cathode.

Type X61M is not suitable for operation with plate voltages less than about 190 volts.

The heater supply for the X61M must not be less than 5.8 volts under any operating condition; it is permissible to use a supply as high as 7 volts with safety.

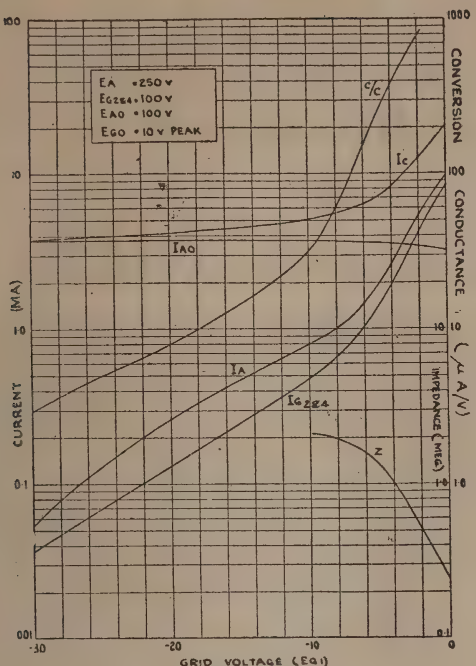


Fig. 5

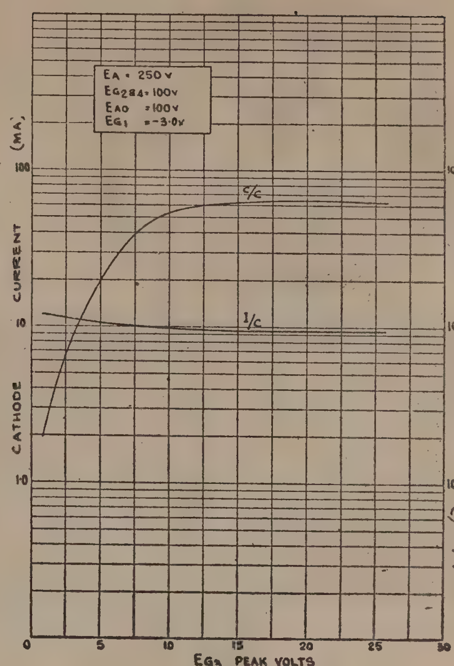


Fig. 7

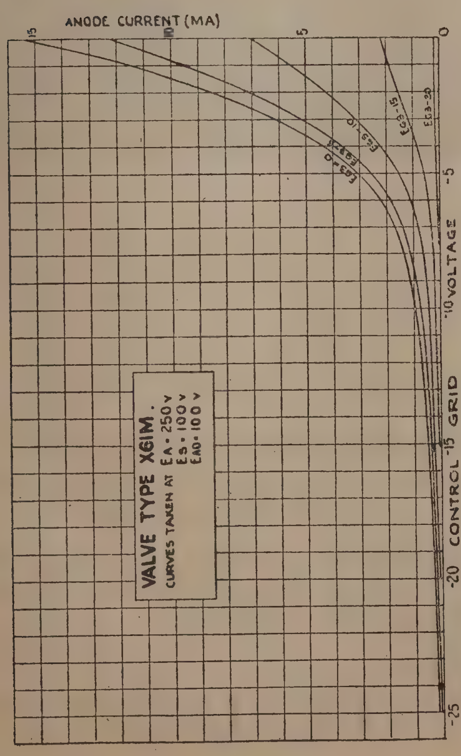


Fig. 6

FOR THE SERVICEMAN: Columbus Model 27

1. GENERAL DESCRIPTION:

This is a 5-valve dual-wave receiver incorporating expanded shortwave tuning. It is notable for high sensitivity on both broadcast and shortwave bands.

The shortwave band covers from 9,400 to 15,600 k.c. This range includes the three principal shortwave bands at 19, 25, and 31 metres, which occupy three times the length of dial scale that would be taken up if the bandspread principle were not incorporated. This results in greater ease of tuning, and means that shortwave stations that would normally be passed over may be tuned in without difficulty.

The oscillator circuit ensures that the oscillator frequency is unaffected by changes in A.V.C. voltage. This greatly reduces the effects of fading on shortwave. To ensure constancy of calibration and alignment, silvered-mica fixed condensers and high-quality trimmers are used in all tuned circuits.

The valves used are as follows:—

6K8 Converter
6K7 I.F. Amplifier
6Q7 Detector Audio Amplifier and A.V.C.
6V6 Power Output
6X5 Rectifier

2. NOTES ON MAIN COMPONENTS:

Power Transformer: Type T57
Output Transformer: Type AN 190
Tuning gang: 2-gang Polar
Wavechange Switch: 2H 2XE

Dial lamp: 2 only Auto Type 6.3v.
Dial Scale: OE 61, OE 161
N.B.: Dial Scale No. OE 161 should be used for all replacement purposes.

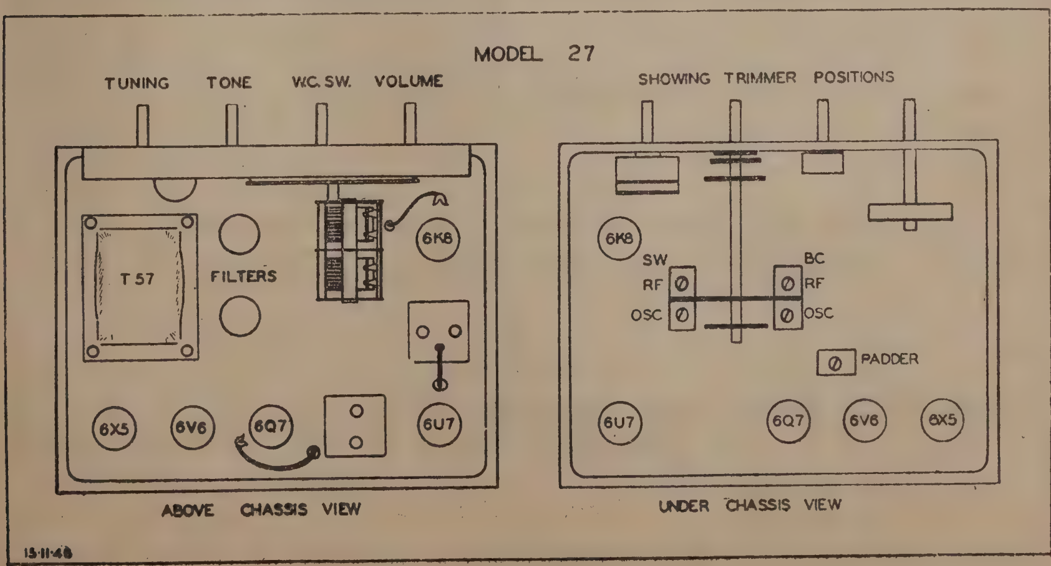
3. ALIGNMENT PROCEDURE:

This is fully covered in Service Bulletin No. 72, "Standard Line-up Procedure for Multiband Receivers," a copy of which is obtainable on application to the Engineering Department of Radio Corporation of New Zealand, Ltd. The intermediate frequency is 455 k.c. and the line-up points are 1400 and 600 k.c. on broadcast and 15,000 k.c. on the shortwave band.

4. VOLTAGE TESTS:

A.C.

High voltage secondary of power transformer, from each rectifier plate to centre tap 350v.
Heater of Rectifier .... 5v.



All other Heaters .... 6.3v.
Dial Lamps .... 4.8v.

D.C. (measured with a meter of 1000 ohms per volt sensitivity, between point indicated and chassis)

First electrolytic condenser (10 μf.) .... 360v.
Second electrolytic condenser (15 μf.) .... 260v.
Screens of 6K8 and 6K7 .... 90v.
Plate of 6Q7 (on 100v. range of meter) .... 35v.

All measurements should be made with the receiver tuned to approximately 1000 k.c. and with no signal input.

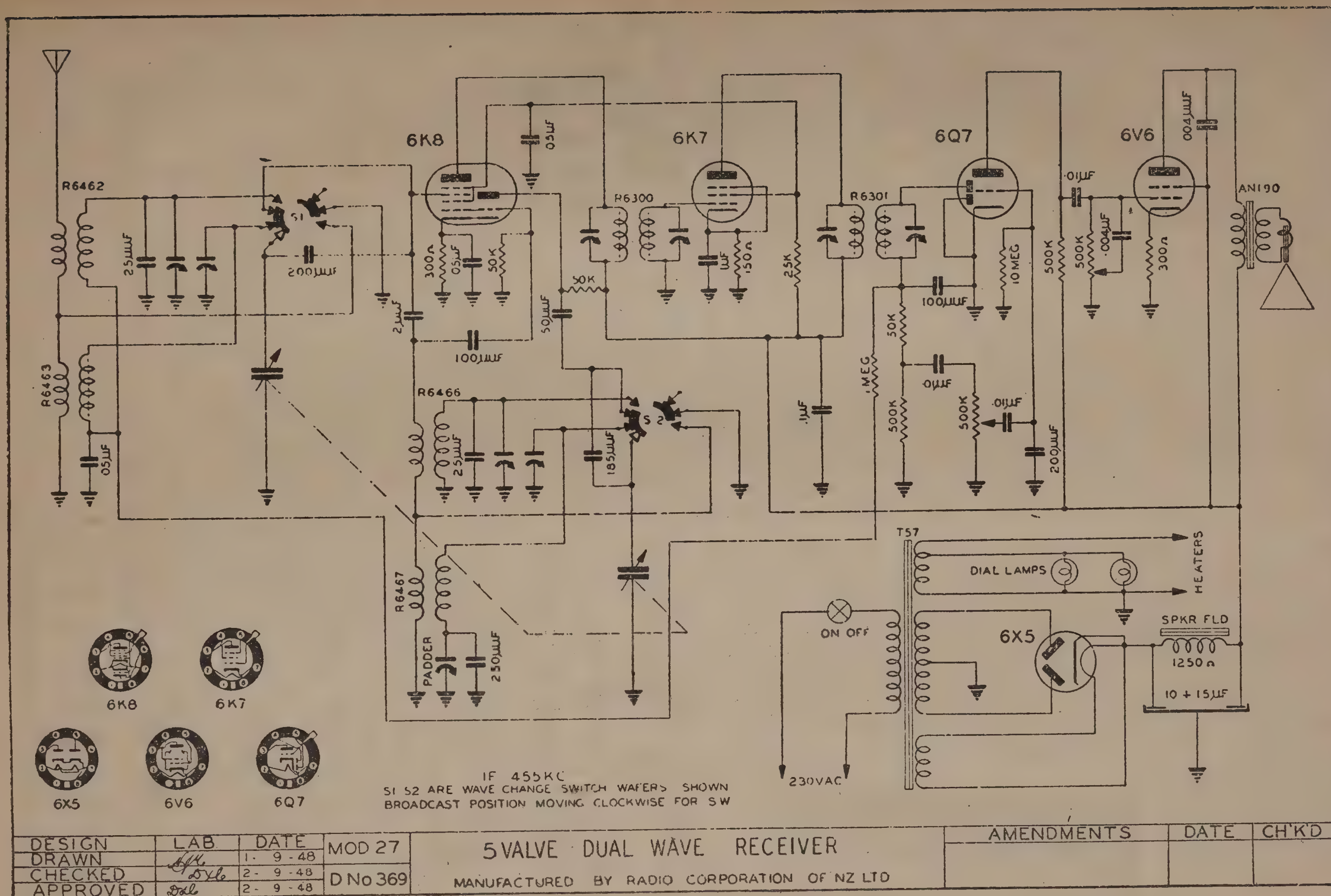
5. RESISTANCE TESTS:

Where measured:		Approx. D.C. resistance in ohms
Across power cord		45
Each rectifier plate to centre tap of power transformer secondary		300
Across speaker field		1250
Speaker transformer primary		450
I.F. transformer coils		8
B/C Aerial Primary		22
B/C Aerial Secondary		3.5
B/C Osc. Primary		2.5
B/C Osc. Secondary		4
S/W Aerial and Osc. Primary	Less than	1
S/W Aerial and Osc. Secondary	Less than	1.25

6. SENSITIVITY TESTS:

(Microvolts input to give standard output of 50 milliwatts.)

Frequency	Input to	Microvolts.
455 k.c.	Grid of 6K7	3500



455 k.c.	Grid of 6K8	60
1,400 k.c.	Aerial lead through standard dummy antenna	10
1,000 k.c.	Aerial lead through standard dummy antenna	12
600 k.c.	Aerial lead through standard dummy antenna	15
15,000 k.c.	Aerial lead through standard dummy antenna	7
12,000 k.c.	Aerial lead through standard dummy antenna	15
10,000 k.c.	Aerial lead through standard dummy antenna	20

A SEASONAL MESSAGE FROM THE PRESIDENT

In the year that is passing the Council has had to assess the present position of the Institute and to plan future progress. I feel our future progress is dependent upon two factors, and I would like to submit them for the serious consideration of every member of the Institute.

The factor I consider of prime importance is that of service—service to members, service to all concerned with the art or science of electronics. But to give such service, the Institute must make many demands upon its members. It is trite but nevertheless true to say that the members as a whole can gain only what the members give. Our thinking in connection with the Institute should be generous and broad, and we should be prepared to take our share of the many tasks which lie to hand. These tasks involve our leisure, cause inconvenience at times, and do not always appear productive, but the total service given in their accomplishment is building an Institute of standing and influence within the community.

Secondly, I consider the attainment of the educational objects of the Institute to be essential for our future. Education in electronics—I use both terms in the broadest sense—is not yet established on sound and definite lines in this country. The technician in this field is unique in that his daily work savours more of the laboratory than the workshop. He requires imagination, a grasp of abstract ideas and powers of analysis and deduction not normally asked of routine workers. His education, then, is a matter of extreme importance to all engaged in the art, and, while certain workers can be trained through the universities and then given experience in research, development, and design, there is a large number of others whom the Institute must help. Such help can be direct or indirect, but help there must be.

At this Season of Goodwill and Good Cheer I would ask you all to say to yourselves: 'What is my place in the Institute?" I have no doubt of the answer.

May I add my personal greetings to those of council and the officers of the Institute for a Happy Christmas and the Brightest of New Years to all members and to the many who have shown support and encouragement throughout the year.

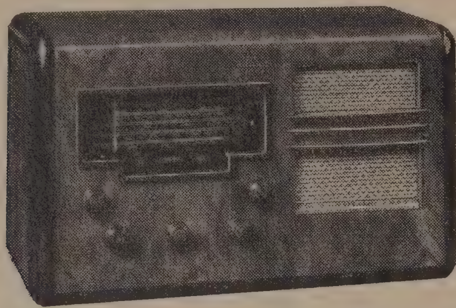
J. W. TODD, President.

NEW PRODUCTS

COURTENAY MODEL 90 "RENOWN"

(Turnbull & Jones, Ltd.)

The Courtenay Model 90 "Renown" is the recently released improved version of the well-known Model 75 and early Model 90. The set consists of seven valves (including magic-eye) in the following arrangement: 6K7G, R.F. amp.; 6K8G, mixer-oscillator; 6B8G, I.F. amp./diode det./A.V.C.; 6J7, audio amp.; 6F6G, pentode output; 5Y3G, rectifier; Y63, magic eye.



Features of the model include temperature compensated plate tuned oscillator, 11 position discriminatory feedback tone control circuit, two levels of fixed feedback, large sized output transformer with feedback from voice coil side, one-piece pressed chassis, separate A.C. switch, and attractive edge-lit dial incorporating band-switch and tone control position indicators.

There are five positions on the bandwidth, giving the following coverages:—

Broadcast: 550-1600 kc/sec.
Shortwave—Complete coverage: 6-18 mc/sec.
Bandspread 31-metre band: 9.47-9.72 mc/sec.
Bandspread 25-metre band: 11.62-12.7 mc/sec.
Bandspread 19-metre band: 14.6-15.7 mc/sec.

The speaker is a 10 in. E.M. type.

In general, the set is a high-performance model on both broadcast and shortwave, has high sensitivity and good signal-to-noise ratio combined with a reasonable order of selectivity. The cabinet is in fancy grained American walnut veneer, and the front is tilted for better vision and listening.

RADIO CONTROL OF MODELS

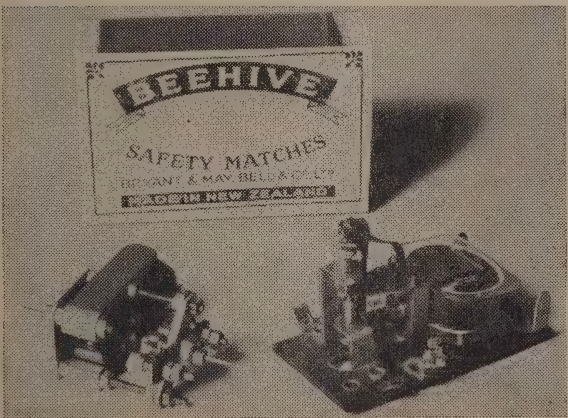
(Continued from page 34.)

rod extending to a rudder horn, now completes the unit, and we can examine its action in detail.

Similar to the escapement method, this operates in a sequence. Commencing in neutral, to press the transmitter key turns the bell crank for a quarter of a revolution to give, say, right rudder, and as long as the key is depressed the right rudder is maintained. On releasing, the small motor now turns the crank to give neutral position again. Another press gives left rudder and release brings it back to neutral. The sequence is then:

Commencing neutral—

(1) Press key—right rudder;
(2) Release key—neutral rudder;
(3) Press key—left rudder;
(4) Release key—neutral rudder.



The speed of the gear by its reduction from the worm gives a total time of approximately one second to make any one turn, so that, if a manoeuvre has to be repeated and a movement wasted, the unwanted movement is elimiated by simply pressing the key for one second and then releasing. To press now gives the desired repetition of the previous manoeuvre.

Now, study what happens if a series of quick taps are given to the transmitter key. The receiver relay intermittently closes and the small motor very slowly rotates. This slow rotation is such that the one second mentioned above can be extended to four or five seconds. To intermittently tap the key for two seconds will give about half the rudder movement. This feature is used to give degrees of turning control, and the model can be trimmed from the transmitter to any circle of turn. From any position, to bring back to neutral, the key is merely pressed for one second and released.

All this is difficult to describe, but one soon gets complete mastery of the technique, and the operator has much more control than by the three positions of the escapement.

Before concluding, here are a few details as to weights, etc., which are of importance if the reader contemplates the fitting up of a plane or boat with radio control.

The battery drain of the rudder unit is very small, as current is only taken while the small motor is running. Three penlight cells will give thousands of operations, and the total weight of unit and batteries is less than three ounces. The three-valve receiver and relay can be built to weigh about four ounces, and associated batteries come to another eight ounces complete, giving a total all-up weight of approximately 1 lb. This is not at all excessive for a plane with a wingspan of 6 ft. or a 2 ft. or 3 ft. model boat, and if the reader's thoughts materialize and he "gives it a go," then the writer wishes him complete success and the object of this article will have been achieved.

DOMESTIC APPLIANCES SUPPRESSION

(Continued from page 19.)

Disconnection of the aerial and earth leads proves whether the interference is being picked up by the aerial system. In making this test, the receiver should not be tuned to a signal, so as to rule out any possibility of misleading results arising from the operation of the automatic gain control. If the interference proves to be due entirely to aerial pick-up, some improvement may be possible by fitting an anti-interference aerial.

If, on the other hand, interference is found to be due to direct pick-up by the receiver components, or that it is being conducted into the receiver by way of the mains leads, the remedies are fairly straightforward. Adequate screening of the receiver will effect a cure in the first instance, while a radio-frequency filter inserted in the mains leads will generally provide an answer for the second case. A typical filter circuit is seen in Fig. 11.

CONCLUSION

Suppression of electrical interference is largely a matter of applying elementary principles of radio-frequency propagation together with a measure of common sense. Remember that all conductors possess inductance, and that inductance is a bad thing to have in series with a capacitor which is doing its best to act as a short circuit at radio-frequencies. Remember also that a suppressor which is too far removed from the offending appliance will be bypassed by the radiation from the unsuppressed wiring which will re-energize the wiring beyond the suppressor. These are two of the points which are most commonly overlooked.

Finally, bear in mind that a great deal of interference is caused by faulty apparatus and wiring—loose connections and inadequate bonding, for example. The cure is obviously to clear the fault, but the difficulty in such cases is to find it. A thorough overhaul of house-wiring, checking up on switches, lampholders, and such like often pays good dividends.

80-40-20 BANDSPREAD TUNER

(Continued from page 11.)

are slightly narrower in terms of kilocycles than is the 80-metre band. The 10-metre band, however, is just over four times as wide as 80, so that if an attempt were made to use this scheme without modification, only a portion of the 10-metre band could be received at one time. The difficulty would be overcome by taking four bites at the 10-metre band, and this would mean four extra positions on the wave-change switch. This would be a little difficult to provide, but it would be comparatively easy to install a separate wave-change switch which tuned the 10-metre R.F. coils to four different frequencies, and also the 10-metre "fixed" oscillator coil to four spot frequencies to suit subsidiary bands of 28-28.5, 28.5-29, 29-29.5, and finally 29.5-30 mc/sec. However, this would be rather cumbersome to operate, as the extra wave-change switch would be constantly in use when the 10-metre band was being worked. However, there would be the advantage of four complete sweeps of the dial for traversing the 10-metre band, and this is bandspread indeed!

ABSTRACT SERVICE

(Continued from page 13.)

The Design and Limitations of D.C. Amplifiers. Part 1. Discussion does not include magnetic amplifiers, but deals with sources of random fluctuations in valve type D.C. amplifiers, sources of disturbance related to external parameters, general design features, stability of H.T. and L.T. supplies, power supplies, and choice of suitable valves.

—Electronic Engineering (Eng.), September, 1949, p. 332.

PHILIPS EXPERIMENTER

(Continued from page 28.)

being turned on with no excitation applied and the modulators from being operated on no load. Now, it will be remembered that the output stage of the exciter has an H.T. switch on the panel, so that the exciter can be turned off independently of the doublers when coil-changing is to be done. Let us examine what happens, therefore, if this switch is turned off in order to change bands once the transmitter is running. The first thing that will happen will be the removal of excitation from the final. As a result, the relay, RL_2, drops out and disconnects the final H.T. The current through RL_3 then disappears, and its contacts open, taking off the H.T. from the modulators. However, all heaters in the transmitter are left running, including that of the time-delay switch, so that once coil-changing has taken place everything can come on immediately the H.T. is re-applied to the exciter. But if we have forgotten to change coils in the final, there will be no grid current, and the final and modulators' H.T. will not come on again until the coils have been changed and the grid circuit tuned up.

It will be noted that in series with the primary of the final's power transformer are two switches labelled "Door." These should close only when the access door or doors to the final are shut, so that, whatever happens, no H.T. can possibly be present in the final compartment if the doors are open for coil-changing.

The overload relay requires a little explanation, as do the installation and adjustment of the relays, but space does not allow these to be covered in this month's Experimenter. These subjects will be dealt with in No. 27, next month, when we will also show a photograph of the completed power supply unit, all supplies being on a single chassis.

CLASSIFIED ADVERTISEMENTS

AUDIO OSCILLATOR

(Continued from page 8.)

the beginning of the attenuator proper, which consists of the two 20 db. sections, in conjunction with a 1000-ohm potentiometer, which gives continuous control of output voltage between the 20 db. steps. Thus a glance at the circuit diagram shows that the 1000-ohm potentiometer can be connected either to the output of the 1 db. attenuator, in which case there are 10 volts available across it, or, in the other two positions of the attenuator switch, across the first 20 db. pad, or across the second. At the same time, the 20 db. pads are connected in cascade, so that on the first position of the switch output is available from 0 to 10 volts; on the second, from 0 to 1 volt; and on the third, from 0 to 0.1 volt. If the potentiometer is calibrated from 0 to 10, this means that any output voltage is available between 10 millivolts and 10 volts.

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